

University of Allahabad Studies

1938

BOTANY SECTION

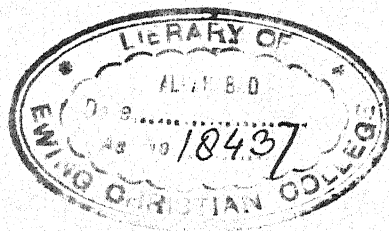
A STUDY OF SOME RUSTS OF ALLAHABAD

PART I

(Morphology of the fungus and germination experiments
with uredospores and teleutospores.)

BY

R. M. ARORA, M.Sc. (ALLD.).



INTRODUCTION

Because of their depredations on a number of important food crops and other plants of economic importance, the "rusts" probably are among the most widely known diseases of plants.

The losses caused by the rusts are colossal in some cases (*e.g.*, wheat) both in India and abroad.

In India the cereals suffer a great loss due to this parasite and according to Butler (1) every year is potentially a year of severe rust in this country.

Besides the economic importance attached to them, the rusts offer an interesting type for study because of the peculiarities of their parasitism.

These rusts are known to infect a variety of plants. Quite a large number of them are found locally at Allahabad at different times of the year. The present work embodies a detailed and illustrated account of some of the local rusts (Uredinaceae).

REVIEW OF WORK DONE IN INDIA

A number of workers in the past tried to study these diseases of rusts. The first account was published between 1871 and 1897 by D. D. Cunningham (2) whose work included the Uredinales. In 1885, A. Berclay began his critical work on the rusts near Simla and during the following 7 years worked out the life-histories of a number of the Himalayan species (3).

Butler (4) described some of the important rusts on crop plants. Butler and Hayman (5) also described some rusts and suggested control measures.

Butler and Bisby in 1931 (6) issued a list of the species of rusts found in India. The work in India was so far more or less academical.

At present a very useful investigation in the cereal rust problem, on an up-to-date and systematic basis is being carried on by Dr. K. C. Mehta, who may be called a pioneer in the field. Due to its great economic importance it soon received the support of the Imperial Council of Agricultural Research. The work has been going on for the last 6 years and several salient features have been studied.

MATERIAL AND METHODS

The material consisted of infected leaves and stems collected from different localities. These places were frequently visited for making a pathological and ecological study of the fungus. The material was brought to the laboratory and kept in the frigidaire for future use.

The uredo and teleuto stages of the different rusts are described. Germination tests were conducted in sterilised watch-glasses. Sterile distilled water was invariably used as a medium, and also for preparing different solutions. The spores were scraped from the leaf by means of a sterilised spear-needle and floated on the medium by just touching the side of the needle containing the spores with the edge of the watch-glasses containing the media.

Measurements of the spores were taken as an average of 100 counts. The germinating spores were examined by keeping them on a slide in lactophenol and the development of the germ tube was studied in hanging drop-cultures in lactophenol. The effect of different factors on germination, the viability of the uredospores in different media under different conditions and the effect of the fungus on the host were studied.

1. UROMYCES ANDROPOGONIS ANNULATI
SYD. ET. BUTLER NOV. SPEC.

On Andropogon pertusus :—

Heavily infected plants of *Andropogon pertusus* were found in the last week of August. The average infection was approximately 10% (Durrel and Parker's scale), which later increased to about 40%. This was the maximum infection for the uredo-stage.

A continuous period of rain and cloudy weather was found to have given a good start to infection which was observed to have reached about 40% and a large number of new plants got infected. The period of incidence was about 2 months.

Uredospores :—

In measuring the uredospores an average of 100 counts was taken. They were 18 to 26 μ by 15 to 24 μ in size. They were roundish to slightly oval in shape. The cell wall was 3 to 4 μ thick. The spores were brownish in colour, with the wall deep brown. The surface was smooth and there were 3 to 4 germ pores visible in surface view.

Germination of the Uredospores :—

Germination tests were made in which glasses containing sterile distilled water. The pores swelled up considerably and after a lapse of about three hours some of them showed a little protrusion on one side. After six hours a distinct germ tube was distinguishable as a sort

of papilla and some of the germ tubes attained a size of 20μ .

Outflow of sporangial contents:—

The germ tube in its earliest stages seemed to be completely filled with cell contents. This was accompanied by vacuolisation taking place in the sporangia. Mostly a single vacuole appeared which increased as the length of the germ tube increased. The outflow of the sporangial contents was rapid at the beginning but it did not keep pace with the increase in the size of the germ tube. As the germ tube increased vacuoles were seen to appear in it. In a well-developed germ tube a large number of vacuoles were found separated by occasional globules of the sporangial contents. The tip of the germ tube always gave a swollen appearance and the contents were comparatively much dense here than at any other part of the tube.

Germ tube and their relation to spores:—

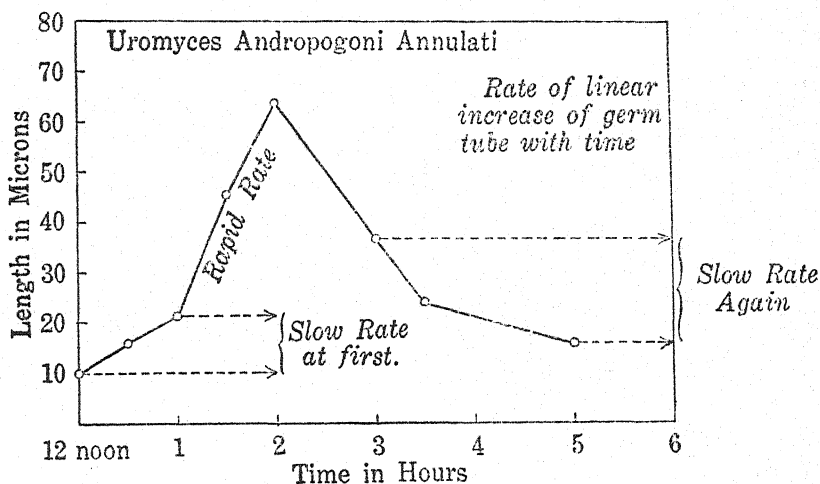
In earlier stages of the germination, when there was a protrusion from the spores, the outer wall showed a distinct breakage and the protruded part was continuous with the intine.

The germ tube was 6 to 9μ in diameter. It never maintained a uniform thickness all through its course but was found to vary at different places. The germ tubes attained great lengths and the largest germ tube measured 1040μ by 6 to 9μ .

Rate of the linear increase of germ tubes:—

The first appearance of a papilla was observed after four hours. From this stage the germ tubes were measured after a regular interval of half an hour. The linear

increase of the germ tubes was measured after every half an hour, and is shown in Graph No. 1.



Graph No. 1

The results show that the rate of the development of the germ tube was not uniform. The rate of linear increase was slow in the first hour, later on it became rapid for the next four hours but finally it decreased as is indicated from the graph.

The average increase for length is about 80μ per hour.

The water, in which the spores were germinated, was tested with Phenolphthaline and Fehling's Solution but no action was noticed.

EFFECT OF DIFFERENT FACTORS ON GERMINATION

Light :—

Ordinarily darkness seemed to favour germination because the spores put for germination overnight showed invariably better germination than when put in the morn-

ing and examined in the evening after the same period. By keeping the spores for germination in artificial light during the night, and also in the dark at the same time, and making a comparative study it was found that light did not, in any way, hinder the germination, but it certainly had some effect on the development of the germ tubes which did not attain the usual size in continuous light. The best germination was attained in light followed by darkness (day and night).

Direct sunlight had a detrimental effect both on germination and on the development of the germ tubes.

Spores were taken from the same pustule and were floated in sterile distilled water in sterilised watch-glasses which were kept in different conditions of light. They were examined after 24 hours and the percentage germination was calculated by the numerator and denominator method.

Oxygen :—

To see the effect of oxygen, watch-glasses containing floated spores were kept in a desiccator containing pyrogallie acid.

Oxygen was necessary for the germination of the uredospores. In an atmosphere devoid of oxygen the spores did not germinate though in some cases incipient stages of germination were observed which may have been due to some oxygen left unabsorbed.

The spores when taken out from the desiccator gave only 39% germination.

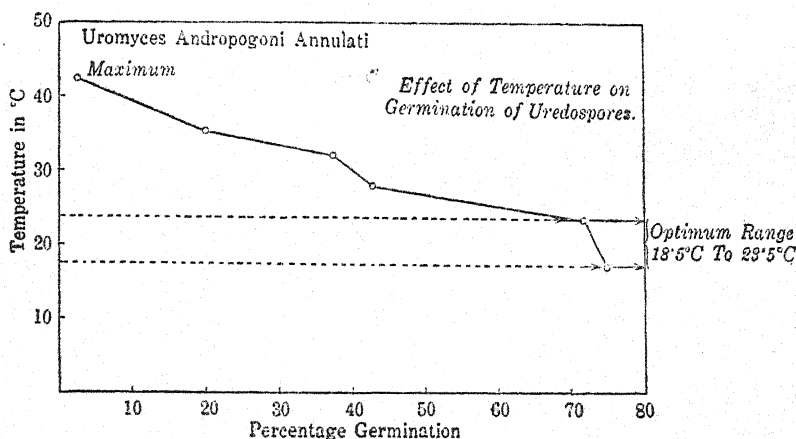
Temperature :—

Temperature had a marked effect both on the capacity of germination and development of the germ tubes.

The optimum temperature for germination was between 80°C . and 24°C . The maximum temperature for germination was between 35°C . and 40°C . At 35°C . there was a little germination which ceased at 40°C . The lower limit could not be found below 5°C . at which the spores showed a good germination.

In December, germination tests under different temperatures were made in the Hearson's nine-chambered incubator. Only seven temperatures could be secured. From the optimum temperature to the maximum limit there was a gradual decrease in the percentage of germination and the same was the case towards the lower limit.

These results are shown in Graph No. 2.



Graph No. 2

Effect of Temperature on the Development of the Germ Tube :—

Temperature had a similar effect on the development of the germ tubes. The temperature which was best for germination was not the one at which greatest development of the germ tube took place. The greatest development of the germ tubes was in the neighbourhood of

30°C. Increase and decrease in temperature beyond 30°C. brought about a decrease in the development of the germ tubes.

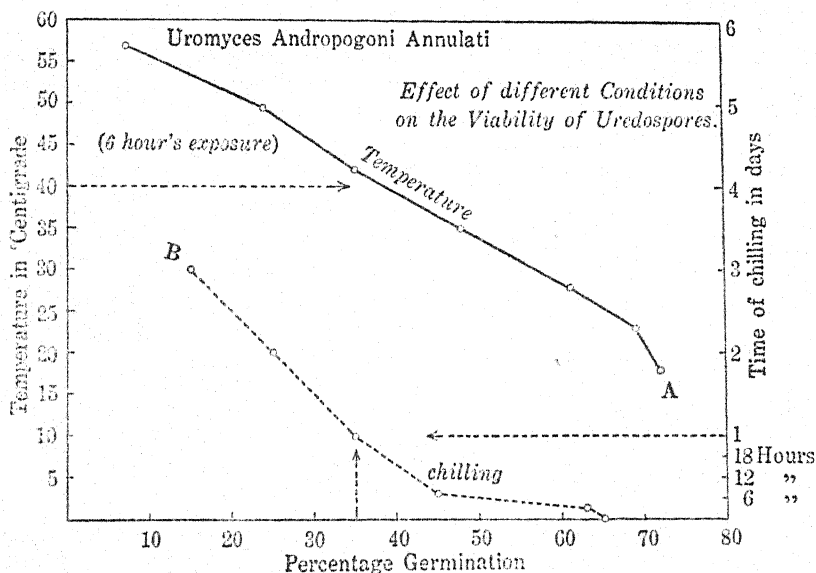
The results obtained in one case are plotted in Graph No. 2, B.

The response to temperature seems to be greater for the germ tubes as indicated by the amount of growth than for the spores as indicated by the rapidity of germination.

VIABILITY OF UREDOSPORES AFTER EXPOSURE TO DIFFERENT CONDITIONS

Temperature :—

To see the effect of different temperatures on the viability of the uredospores, the spores were put in dry,



Graph No. 3

sterilised watch-glasses in different compartments of the nine-chambered incubator. After an exposure of six hours they were put for germination in ordinary sterile distilled water at the room temperature (18.5°C.). They

were examined the next day and the germination was noted.

From an initial germination of 80% they showed a gradual decline from 76% at 25.5°C. to 23% germination at 48.5°C. At 57°C. the germination was only 5%. The result obtained are shown in Graph No. 3, A.

Effect of chilling the uredospores:

The spores germinated well when chilled on ice for short periods and the germination started immediately after putting them in water. Chilling for longer periods showed a detrimental effect on the germinating capacity of the spores. Graph No. 3, B shows the fall in percentage germination of the spores after chilling them for different periods.

Maturity of Spores:—

The criteria of full maturity have always been very difficult to specify definitely. Here maturity of spores is taken in the sense that the spores are spontaneously detachable from the tissues. From the day of the first appearance of the pustule it took 5 to 7 days to bring the spores to a condition when they appeared as a red powdery mass and were liberated by a slight shaking of the leaf. Germination tests were made every day and it was observed that the early spores showed very little germination. One remarkable point observed in this case was that the germination started very late in the case of the spores from the pustule observed the very first day, the papillae being observed after a lapse of 8 or 10 hours. The full germ tube developed in about 20 hours. The spores every day showed better germination and at the end of the 6th day it was found to be rather normal. It can safely be said here that the spores attained full maturity in about a week after their first appearance. The germination obtained on each day is given below.

Initial germination 78% (spores from well-developed pustule)

Date	No. of days after appearance when examined.	Germination started after.	Percentage germination.	Average length of germ tubes.
7-11-36	1	18 hours	5%	103 μ
8-11-36	2	10 hours	15%	270 μ
9-11-36	3	6 "	40%	397 μ
10-11-36	4	4 "	44%	455 μ
11-11-36	5	4 "	61%	543 μ
12-11-36	6	...	69%	559 μ
13-11-36	7	...	73%	573 μ

Longevity:—

The longevity of the uredospores of this rust seemed to be considerable. The spores from material collected in August were viable even in February. The viability was much more in the material kept at lower temperatures (5°C.). The viability decreased with increase in time as shown by the following results.

Percentage germination

Date on which material collected.	Date on which examined.	From material kept in room.	From material in frigoridare (5°C.).
17-8-36	20-9-36	68%	71%
Initial ...	7-12-36	51%	58%
percentage ...	19-1-37	39%	52%
75%	22-2-37	23%	43%

From the above results it appeared that longevity of the uredospores was considerably enhanced by moderately low temperatures and high humidity.

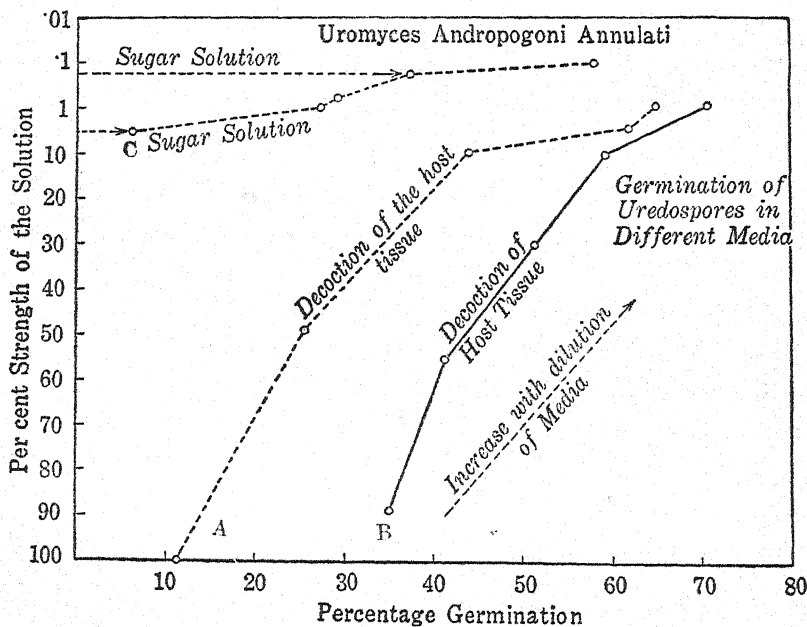
GERMINATION OF UREDOSPORES IN DIFFERENT MEDIA

Decoction of host tissue :—

The decoction was made in two parts

- (1) from mature leaves.
- (2) from young leaves 6 days old.

Various concentrations from cent-per-cent to 5% were tried. Germination was definitely hindered in the decoctions of both young and mature leaves. The germination



gradually increased as the dilution of the decoction was increased (Graph No. 4, A).

In all cases the development of the germ tubes was very meagre and in the case of greater concentration the average length of the germ tube was about one-fourth of what they attained in distilled water.

Decoction of the horse dung :—

There was a little germination in 90% decoction of horse dung and in lower concentrations the germination was secured but in no case was it more than that in distilled water. Neither any stimulatory action as to rapidity nor greater development of germ tube was noticed (Graph No. 4, B).

Sugar solutions :—

Before proceeding with the experiments under this head the total amount of sugars present in the leaves was found out. It was approximately 0.03%. In younger leaves (6 days old) it was 0.044% approximately.

Sugar solutions were made (by weight) of various strengths, from .01% to 5%. Germination was hindered in all cases but it was best in the solutions of lower concentrations.

The germ tubes showed a better development in length up to the solutions of .8% strength and in 5% concentration the germ tubes did not even attain half the normal size. The results are shown in Graph No. 4, C.

Acid solutions :—

Before proceeding with the experiments under this head, the acid content of the leaves was found out. It was .021%. Two acid solutions were tried: (1) Oxalic acid and (2) Copper sulphate solution.

These were tried in 5 different concentrations (by weight) and germination tests were made in each.

Oxalic acid did not appear to have any inhibitory action in concentrations as high as .05%. In higher concentrations the germination was retarded. Copper sulphate solution had a retarding effect in concentrations as low as .005%.

Ethyl alcohol :—

Ethyl alcohol seemed to stimulate germination in lower concentrations. In a 2% solution of ethyl alcohol the germination was approximately the same as it was in distilled water but the process seemed to be much quicker, as after a period of 3 hours several spores had produced germ tubes 15 to 20 μ in length. Germination was hindered in 5% solution of ethyl alcohol.

TELEUTOSTAGE

The teleutostage was first noticed on the 11th November, 1936. The teleutosori were blackish to dark brown in colour and were much more densely distributed on the leaves. They were mostly on the lower surface of the leaves, solitary or aggregated.

Unlike the uredospores the pustules in this case were not very deep-seated and gave an appearance of being rather superficial in nature. In earlier stages they were found mixed with uredospores. Contrary to Saksena's (8) observations the teleutosori were not observed on the upper surface of the leaves in spite of vigorous search.

Teleutospores :—

They were one-celled structures round to oval in shape. They were dark brown in colour and the walls were very thick. The stalks were hyaline. The stalks were about 35 to 50 μ long and 10 μ thick. At the point of attachment to the spores they were about twice as thick as at the base.

In every case the stock had a depression at the point of its attachment to the spore.

The teleutospores were 25.3 to 34 by 18.86 to 26 μ in size.

Germination of Teleutospores :—

An attempt was made to germinate the teleutospores by a number of contrivances. They were put for germination in ordinary distilled water, and in sugar solutions of various concentrations.

They were chilled continuously for different periods from 5 days to 2 months and then their germination was tried in different solutions.

An alternate wetting and drying was tried (Dietel 1921) (8) with an interval of 2 days for 28 days. Some of the chilled spores were given a temperature of 30 to 45°C. and then put for germination.

Some of the chilled spores were put on leaves of *Crinum latifolium* kept in petridishes at different temperatures. A decoction of *Crinum* leaves was also tried and both the chilled and fresh teleutospores were put for germination. They were examined continually for about a month but no sign other than germination was seen.

2. PUCCINIA RUELLIAE (B. ET BR.) LAGH. ON RUELLIA PROSTRATA.

Infected plants of *Ruellia prostrata* were noticed in the first week of October. The highest infection at this stage was 30% but about 20% was the general rule. Plant leaf infection continued from October to February.

Uredospores :—

The uredospores were oval in shape and the wall was spiny. The thickness of the cell wall varied in different

spores and was 2 to 6 μ . The shape also was not uniform, some of the spores being greatly elongated. In all the cases 2 germ pores were visible in surface view.

LIBRARY OF
LYING CHRISTIAN COLLEGE
ALLAHABAD

Germination of the uredospores :—

Germination tests were made as in the previous case. The early germ tubes gave quite a different appearance in this case. The germ tubes appeared to start from a crevice in the wall and just after emergence they ended in a knob-like swelling. This swelling appeared to be much denser in contents while the posterior part of the germ tube did not show any such phenomenon. At this stage there was absolutely no sign of the vacuoles appearing in the spore. As the germ tube progressed further, it appeared much thicker and the contents increased gradually.

In a fully developed germ tube the cellular contents were evenly distributed throughout. They were separated by empty spaces—the vacuoles. The end of the germ tube which gave a knob-like appearance was quite like the other part of the tube at this stage.

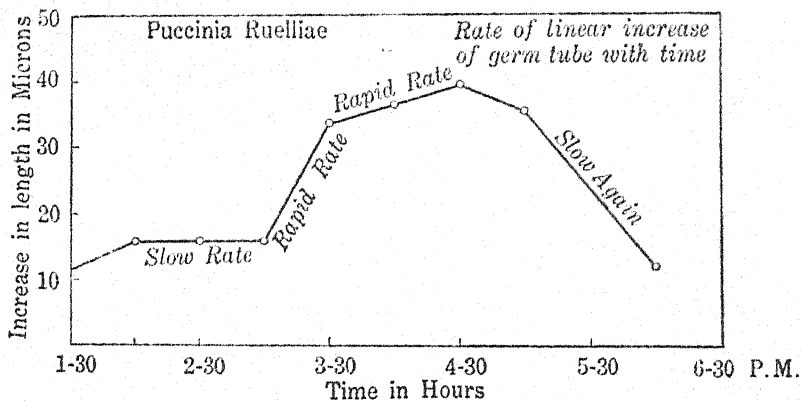
Relation of the germ tubes with the spores :—

Well-developed germ tubes showed that the outer wall was not connected to it. In later stages, the change in colour of the spores made it still more difficult to see the connection of the germ tube with the spore wall.

Rate of the linear increase of the germ tubes :—

The observations were started after 3 hours. No definite measurements could be made up to 1 or 2 hours as the formation of the germ tube up to a certain point was rather sudden. The germ tubes at this stage were 19 to 21 μ long. After this regular measurements were made at an interval of half an hour. As in the case of

U. andropogoni annulati the linear increase in germ tubes was measured every half an hour. The results were identical in both in broad outlines as is shown in Graph No. 5. The average increase in length was about 60 μ per hour.



Graph No. 5

EFFECT OF DIFFERENT FACTORS ON GERMINATION

Light :—

Experiments were made as in the previous case. Light has some retarding effect on germination in this case. The germination in continuous light was much less than in the dark under the same conditions.

Spores put for germination in direct sunlight gave no germination at all during the day but in the evening some spores were found to have germinated. Spores put at the same time in the room germinated earlier. As the spores germinated at temperatures considerably higher than the temperature in sunlight it follows that direct sunlight had some inhibiting effect on the germination.

Oxygen :—

The experiment was performed as in the previous case but was also conducted under different conditions of

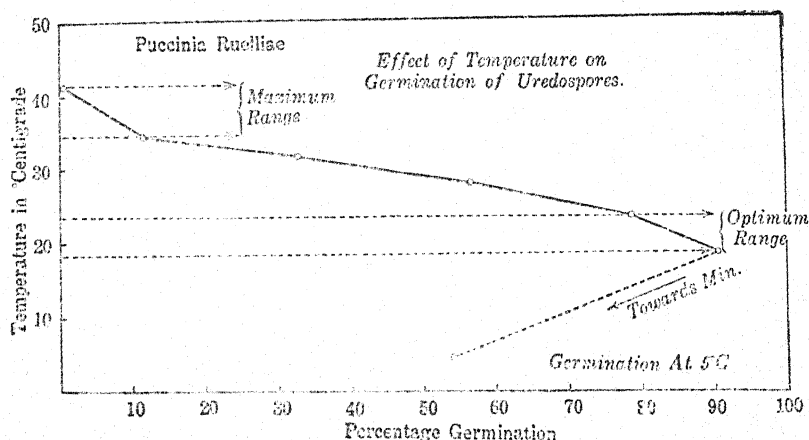
temperature, light and darkness. The temperatures tried were 27°C. (room temperature), 15°C., 5°C.

Germination was not observed in any case. The spores were found to have swelled as in the case of germination in normal conditions and some of the spores were considerably elongated but no definite germ tubes were seen.

Temperature :—

Lower temperatures showed good germination. At 5°C. also the germination was approximately as much as at the room temperature. In higher temperatures there was a decrease in germination. The maximum limit was between 35°C. and 45°C. At 45°C. no germination took place.

In the nine-chambered incubator the gradual fall from the optimum to the maximum was observed. From optimum towards the lower limit there was not a great difference in germination as in the case of *U. andropogoni annulati*. The results are shown in Graph No. 6.



Graph No. 6

Effect of temperature on the development of the germ tubes :—

The best development of the germ tubes was obtained in 18.5°C. to 23.5°C. This range may be called the optimum for this rust as no definite temperature between this was available. In lower temperatures the germ tubes were thinner and did not attain great lengths.

The increase in temperature resulted in stunted but thick germ tubes.

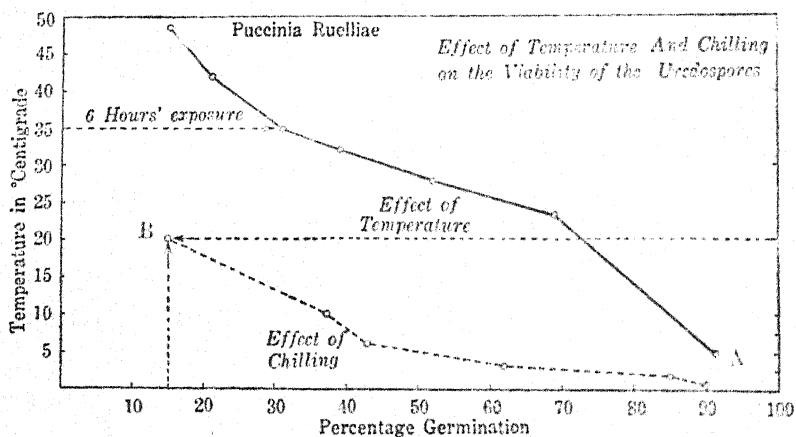
The results obtained are shown in Graph No. 6.

VIABILITY OF THE UREDOSPORES : AFTER EXPOSURE TO
DIFFERENT CONDITIONS

Temperature :—

Experiments were performed as in the previous case. The exposure given in this case was modified to 3 different periods, *e.g.*, 2 hours, 4 hours, and 6 hours.

2 hours' exposure did not have any conspicuous effect. Exposure to 5°C. was advantageous and had a definitely



Graph No. 7

good effect, germination being quicker and the spores producing longer and thicker germ tubes. 24 hours'

exposure in the frigidaire ($5^{\circ}\text{C}.$) initiated the germination and spores when put in water showed distinct protrusions and the usual broken appearance. After 18 hours' exposure to $48.5^{\circ}\text{C}.$, only 5 to 7% germination was observed (Graph No. 7, A).

Effect of chilling :—

In this case also chilling for short periods was beneficial for germination. 2 hours' chilling gave approximately the same results as 6 hours' exposure to $5^{\circ}\text{C}.$ Chilling had a marked effect on the rapidity of germination. The spores showed incipient germinating stages when removed from ice.

The germ tubes also developed rapidly and in 3 hours acquired the lengths attained in 7 hours under ordinary conditions. A period of 4 hours' chilling also gave nearly the same results as for 2 hours. Chilling for 8 hours was found to have some detrimental effect. The germination percentage was lower and the spores which did not germinate were shrivelled. The germ tubes, however, showed the same rapid growth. 16 hours' chilling brought down the germination from 91% to 43%.

The spores were viable up to 3 days with continuous chilling. Graph No. 7, B shows the results of different times' chilling.

Effect of sunlight :—

Sunlight seemed to have a similar effect, as in the previous case. By a continuous exposure to sun for 6 days the germination percentage was brought down from 90% to 58%. The spores put for control in the room gave a germination percentage of 83%. An exposure of 8 hours to sunlight brought down the percentage to 80%.

Maturity of spores :—

On the first day of the appearance of the pustule as a small dot-like structure, no germination was obtained. It was only on the third day that the spores detached from the pustules gave 20% germination. The best germination was obtained after the 10th day (91%) when the pustules were quite big.

The early spores showed germination considerably later than the fully mature ones.

Longevity :—

Material collected in October gave a germination of 23% in February. Material kept at 5°C. gave a germination of 47% on the same date. The viability of the spores was considerably reduced after 5 months. The viability seemed to be inversely proportional to the age of the spore.

GERMINATION OF UREDOSPORES IN DIFFERENT MEDIA

Decoction of host tissue :—

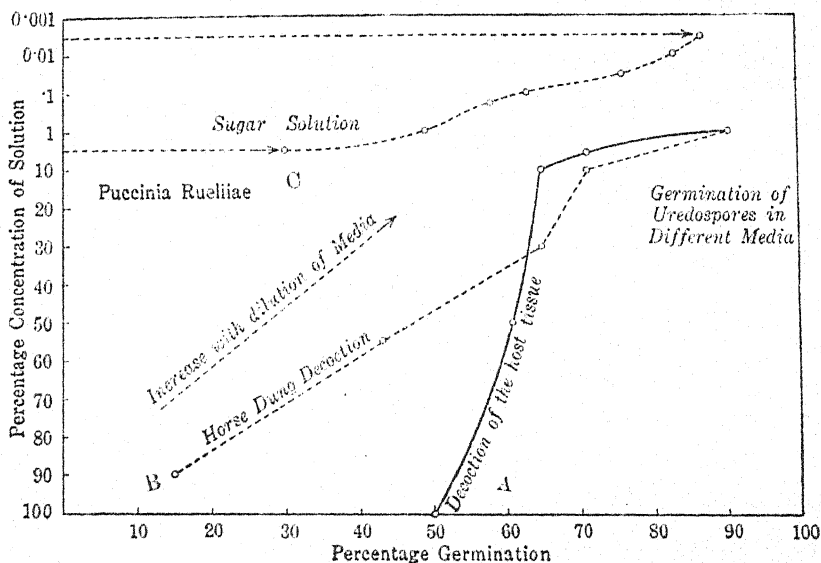
The decoction was made from young leaves selected from the same plant.

The same concentrations were tried as in the previous case. A cent-per-cent decoction gave 50% germination. In 1% solution there did not seem to be any inhibitory action on germination and it was quite normal. As in the previous case the germination increased with the dilution of the decoction. There was no effect on the germ tubes (Graph No. 8, A).

Decoction of horse dung :—

In 90% decoction of horse dung very little germination was obtained. The germination increased with the

dilution of the medium. There was no stimulatory action. The percentage germination obtained in each case is shown in Graph No. 8, B.



Graph No. 8

Sugar solution.—

Before going in for this experiment the sugar content of the leaves was found out. It was approximately 0.0068%.

Sugar solutions of various strengths from 0.005% to 5% were tried. As before, the germination was best in the lower concentrations. The higher the concentration the lower being the germination percentage (Graph No. 8, C).

In 5% solution practically no swelling of the spores was observed.

Acid solution:—

As before only 2 acids were tried. The acid content of the leaves was 0.0017%.

Copper sulphate had a retarding effect on germination in low concentrations of .001%. Oxalic acid also had a similar effect in .005 concentrations. Spores put for germination with powdered sulphur did not germinate.

Ethyl alcohol :—

Lower concentrations had no effect and the germination was normal. Higher concentrations (5%) had a definitely retarding effect. No stimulatory action was observed.

TELEUTOSTAGE

The teleutostage was first noticed on 6-12-36. The teleutosori were dark brown in colour and were distributed on both surfaces of the leaves. Like the uredosori they were often arranged in a circular group. These pustules were deep-seated.

Teleutospores :—

The teleutospores were stalked, bi-celled and thick-walled. The stalks were hyaline. The point of attachment of the stalk to the spore was not uniform, varying from polar to equatorial with various intermediate insertions.

In spores, whose colour had faded, the two cells showed distinct outlines and some globular contents were seen inside.

The upper cell was slightly smaller than the lower one. They were 18.6 to 22 μ by 25.8 to 27 μ in size.

Germination of Teleutospores :—

In order to secure their germination the teleutospores were given different treatments as in the previous case. They germinated after continuous freezing for 25 days, and then putting them for germination in distilled water for 4 days.

A germ tube came out from each cell starting somewhere laterally on the side of the cell. The germ tubes contained some globular contents which were probably transferred from the cells. In one case the branching of a germ tube (at the end) into 4 short branches was observed under a water immersion lens, but no sporidia could be seen.

Infection of the plant with Teleutospores :—

The frozen material of the teleutospores was laid on a piece of moist blotting-paper placed in the lid of a petri-dish. This lid was held inverted, resting on 3 glass rods fixed in the soil, of a flower pot containing a plant of *Ruellia prostrata* (modification of Craigie's method) (10).

The plant was atomised at the beginning and also on subsequent days.

Two such trials were made but there was no infection. This method of infection was also tried on leaves of *Crinum latifolium*, but without success.

3. PUCCINIA PENNISETI—Zimm. on Pennisetum typhoideum Rich. (Bajra).

Heavily infected plants were found in the first week of November. The highest infection was about 60% but 40% to 50% was the general rule. This rust is known to have been found at Allahabad in September (8) but this year it was not found anywhere up to October 9. It was found in practically every locality and was available up to the third week of January in plots which were sown for fodder.

This rust has been fairly fully described by Butler (4). The teleutosori need a little mention. They were almost always covered with little membranous tissue which

was the remains of the epidermis. By removing this covering, the black pustules became distinct. Like the uredospores, the teleutospores were never scattered free on the leaf surface but were deeply seated and held firmly in the tissue.

The uredosori were found more on the upper surface than on the lower one.

Uredospores :—

They were examined and in their morphological characters they agreed with Butler's (4) description.

Germination of the uredospores :—

The germination started after 5 hours by the protrusion of a small knob-like structure which seemed to start from the wall but not at any regular place. The germ tube advanced as in irregular swelling but later on a definite tube was established.

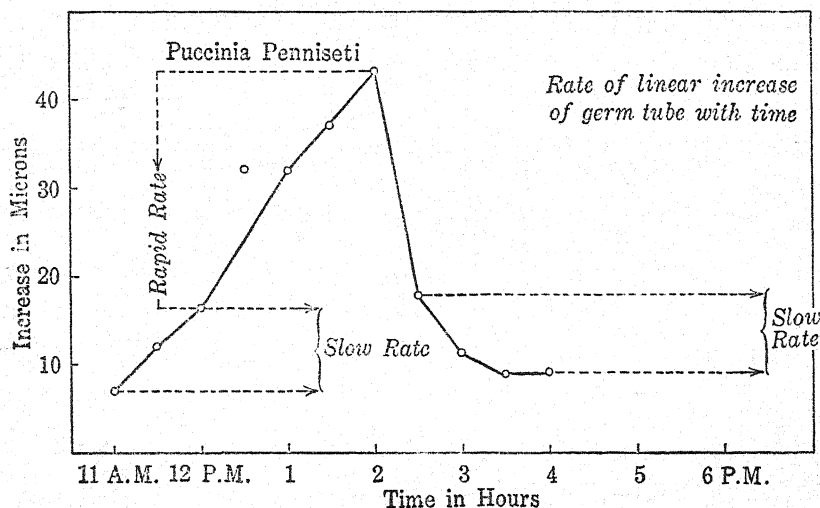
The germ tubes in earlier stages were entirely filled but no definite vacuolisation in the sporangium could be seen. As the germ tube progressed the posterior end showed vacuolisation, the advancing end being always full of contents.

Germ tubes and their relation to the spores :—

The spiny surface of the wall of the spores presented a great difficulty in ascertaining the connection of the germ tube with the wall of the spore. In lactophenol (11) some of the spores were seen to have lost the pigment and became rather transparent. In these spores it was noticed that the tube had its connection directly with the interior of the spore, the inner wall being continuous with the wall of the tube.

Rate of the linear increase of the germ tube :—

Regular half hourly measurements were started after about 4 hours from the time the spores were put for germination. The increase every half an hour is shown in the Graph No. 9.

*Graph No. 9*

In these observations the usual course of first slow, then rapid, followed by slow development of the germ tube is clearly seen.

EFFECT OF DIFFERENT CONDITIONS ON GERMINATION

Light :—

An inhibitory action of light was observed. The spores put for germination in continuous light showed about 40% germination, while in total darkness (at the same temperature) the germination was 87%. The germ tubes were better developed in the dark and some of them were branched at their anterior ends. The spores kept in darkness for 3 hours and then removed to light gave 63% germination. Spores kept in the morning and examined

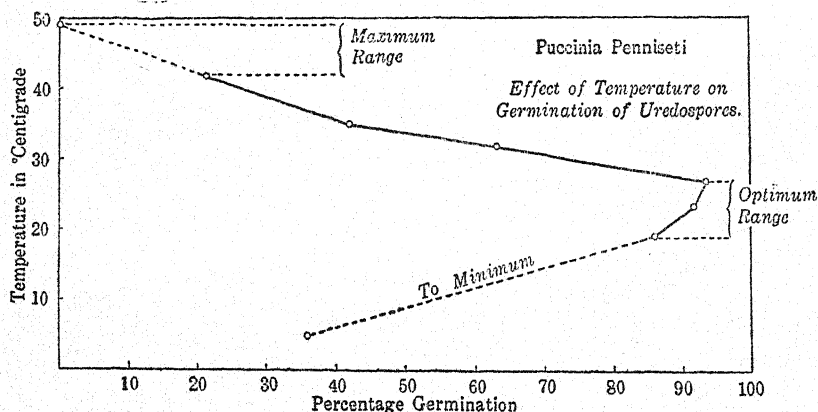
in the evening gave about 36% germination and those kept overnight gave about 86% germination. The spores seemed to have received a stimulus in the dark.

Oxygen :—

No spores germinated in an atmosphere devoid of oxygen. When the spores exposed to such atmosphere were taken out and kept under normal condition they showed only 10% germination.

Temperature :—

The temperature effect was seen in the nine-chambered incubator. The optimum temperature for germination of this rust was between 23.5°C . and 28°C . The maximum limit up to which the spores showed germination was near



Graph No. 10

about 42°C . There was a gradual fall in germination from the optimum to the maximum and also to the lower limit as shown in Graph No. 10.

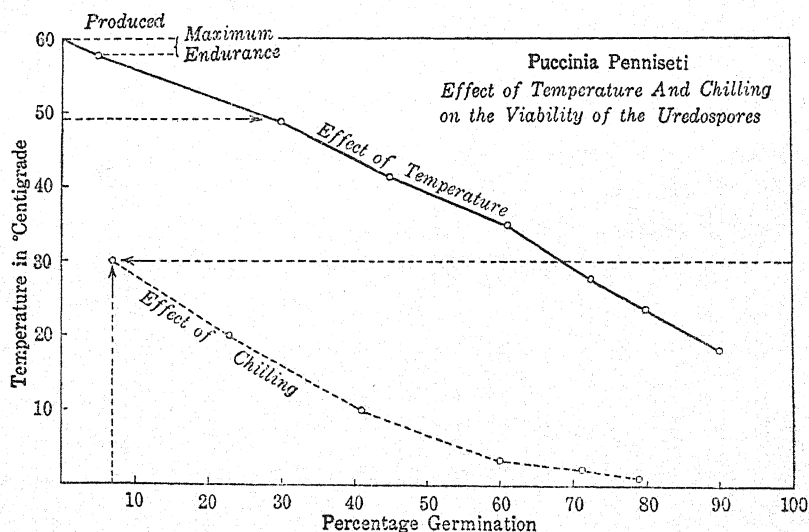
At 5°C . the germination was about 36%.

VIABILITY OF THE UREDOSPORES AFTER EXPOSURE TO DIFFERENT CONDITIONS

Temperature :—

As in the previous cases, the effect of temperature on the viability of uredospores was seen by putting the spores in the nine-chambered incubator for different periods of time. Exposure to lower temperature was given in the frigidaire ($5^{\circ}\text{C}.$).

After an exposure of 6 hours, the uredospores showing an initial germination of about 90%, showed a gradual decline from 80% germination at $23.5^{\circ}\text{C}.$ to 30% germination at $49^{\circ}\text{C}.$ After an exposure of 6 hours to $58^{\circ}\text{C}.$



Graph No. 11

in a bath the spores showed a germination of 4% to 6%. A 6 hours' exposure to $5^{\circ}\text{C}.$ seemed to initiate the process of germination, as the early stages of germination were observed immediately after putting them in water. The germination was practically normal. One week's exposure to $5^{\circ}\text{C}.$ lowered the germination to 56%.

The average fall at different temperatures is plotted in the Graph No. 11, A.

Effect of chilling :—

Germination was initiated early by chilling up to 4 hours and the germination percentage was reduced to 70% after 2 hours' chilling. After 2 days' chilling it was brought down to 23%. By 4 days' continuous chilling there was a total loss in the viability of the spores. The fall in % germination on different days is plotted in Graph No. 11, B.

Effect of sunlight :—

Spores put in direct sunlight (glass-filtered) for 15 days showed a germination of 43%. The initial germination in the room (18°C.) was found to be 90%. The spores put for control at the room temperature for 15 days showed a germination of 69%.

Spores put at 23.5°C. for 15 days also showed about 60% germination. The temperature in the open during those days was 22°C. The loss in germination may safely be attributed to sunlight.

Maturity :—

The spores from pustules observed the very first day gave no germination. When scraped from the leaves they always came out aggregated in groups along with some tissue of the leaf. On the second day they gave 30% germination. Pustules which were 4 to 5 days' old gave practically a normal germination of 82% to 85%.

In this case the pustules developed very rapidly and in about 5 days' time they grew to about 3 mm. in length. The spores appeared free from the tissue in 4 to 5 days.

Longevity :—

The spores from the material collected in November were also viable in March. In this case there was no

marked difference between the percentage germination of the material kept in the room and in the frigidaire.

GERMINATION OF THE UREDOSPORES IN DIFFERENT MEDIA

Decoction of host tissue :—

Separate decoctions were made from mature and young leaves. They were tried in different concentrations and the percentage germination was noted in every case.

In a cent-per cent decoction of mature leaves there was no germination while in the decoction of young leaves of the same concentration there was 31% germination. The germination increased as the dilution was increased. The germination obtained in each case was as follows :—

There was a gradual increase of germination percentage with the increase of the dilution.

The mature tissue seemed to contain some toxic substance which inhibited germination in the cent-per cent decoction.

Decoction of horse dung :—

There was no stimulatory action of this on germination. As usual the best germination was in solutions of low concentrations.

Sugar solutions :—

The sugar content of young leaves (8 days' old) was .025%. Various concentrations (by weight) were tried. Germination was hindered in higher concentrations, the lower ones having no particular effect. There was no effect on the germ tubes.

Acid solutions :—

The acid content of leaves (8 days' old) was .0021%.

Two acids were tried as usual.

Copper sulphate solution had an inhibiting effect even in concentrations of .001%. The spores were all dead in .05% solution.

Oxalic acid showed quite good germination in lower concentrations but it had a total inhibiting effect in .1% solutions.

Ethyl alcohol :—

No stimulatory effect was seen in 1% solution. In a 5% solution the germination was brought down from 90% to 62%.

TELEUTOSTAGE

The teleutostage was first found on 4-12-1936.

Teleutospores :—

They have been fully described by Butler (4). He mentions that the teleuto germinates as usual. An attempt was made to germinate the teleutospores by giving them various kinds of treatments as in the previous cases, but no germination was observed.

4. PUCCINIA ROMAGNOLIANA MAIRE AND SACC. on *Cyperus rotundus* (Motha grass)

This rust was found in the last week of September. The infection at the beginning was nearly 20% which in later stages increased to about 30%.

The pustules were all on the lower surface of the leaves. These were arranged longitudinally along the veins and were mostly about 2 mm. in length, but occasionally some pustules were more than 6 mm. in length.

Sometimes more than two pustules were confluent and formed quite a large red patch on the leaf.

Uredospores :—

They were round to ovate, smooth-walled and of a brick red colour. They were 14 to 23.5 μ by 19—32.5 μ in size. The wall was thin and about 3 μ in diameter.

Germination of the uredospores :—

Germination tests were made as usual. The spores imbibed water and increased in size. The swelled spores were 26 to 33 μ by 22 to 27 μ , thus showing an increase of 5 to 6 μ in diameter. On pressing the uredospores in lactophenol the contents were seen coming out through the germ pores. This gave the idea that probably the in-take of water was effected through these pores. The germ tube started as a small vesicle filled with cell contents. This protrusion gradually developed into the germ tube.

Germ tubes and their relation to spores :—

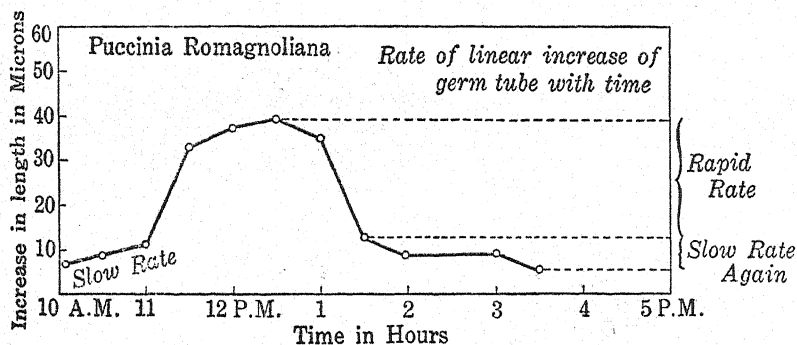
In the early stages of its development, it could not be clearly seen from which part of the spore exactly the germ tube arose. In advanced stages when the posterior part of the tube was empty and appeared hyaline, the outer part of the spore showed no connection with the germ tube.

Rate of linear increase of the germ tubes :—

Observations were taken every half hour as in previous cases. The measurements were started when the early vesicle-like stages were observed.

In this case also the germ tube developed gradually showing a rapid increase in the middle of the process

which became slow again at the end. The increase every half an hour is plotted in Graph No. 12. The average increase per hour was about 41μ per hour.



Graph No. 12

The water, in which the spores were germinated, was tested by phenolphthaline and Fehling's solution for acid and sugary exudations but there was no reaction.

EFFECT OF DIFFERENT FACTORS ON GERMINATION

Light :—

Light had a distinctly inhibitory effect on germination. Spores put for germination under the same conditions of temperature showed 83% germination in darkness and only 14% in continuous light. Spores put in diffused light in the room showed poor germination until kept overnight. Germination was quicker in the dark. The initial percentage was about 71% in the room in daylight. The spores kept in darkness for 3 hours and then removed to light gave normal germination. Darkness seemed to be essential in stimulating the germination.

Oxygen :—

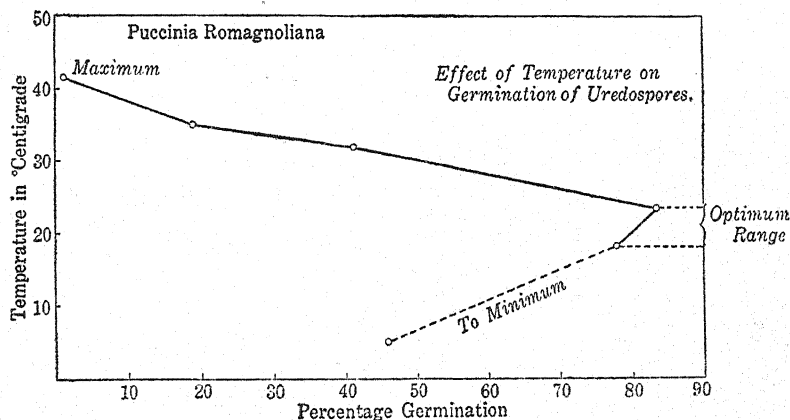
As in the previous cases the spores did not germinate in an atmosphere devoid of oxygen. Spores kept in such atmosphere, did not give normal germination, when put

in usual conditions. In the latter case the germination was only 31%.

Temperature :—

Temperature is an essential factor in controlling germination. Germination was stimulated in lower temperatures but the percentage germination was best at 23.5°C . which seemed to be in the neighbourhood of the optimum. The maximum temperature at which the spores could germinate was near 35°C . The spores showed quite good germination at 5°C .

There was a gradual fall in germination percentage from the optimum to the maximum. This is shown in Graph No. 13.



Graph No. 13

Effect of temperature on the development of the germ tube :—

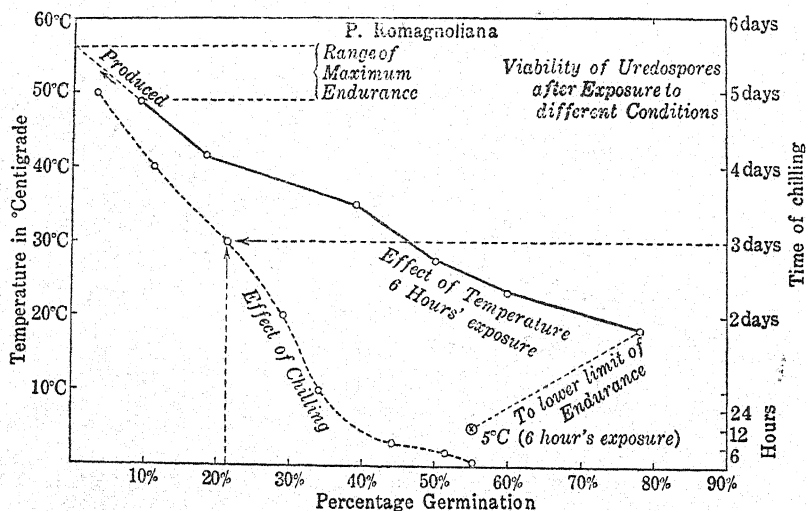
In this case the best development of the germ tubes was at the same temperature, which was also the most favourable one for germination. At 23.5°C . the germ tubes were seen to attain the biggest size and their thickness also showed an increase of about $3\ \mu$. Increase and decrease in temperature was responsible for gradual lessening of the germ tubes.

The results obtained in one case are given in the table below and plotted in Graph No. 13.

VIABILITY OF THE UREDOSPORES AFTER EXPOSURE TO DIFFERENT CONDITIONS

Temperature :—

As before, the temperature effect was seen by putting the spores in different compartments of the nine-chambered incubator and giving them an exposure of 6 hours. After that they were put in sterile distilled water as usual. Next day their germination was noted. From an initial germination of 82% at 18°C. the spores showed a gradual decline to 20% at 41.4°C. After 6 hours' exposure in an incubator at 58°C. the germination was hardly 2%.



Graph No. 14

Exposure to 5°C. for 6 hours had a great stimulating effect on germination which was quicker in this case. The percentage of germination was normal. 24 hours' exposure to 5°C. gave practically the same results but

exposure to 1 week brought down the percentage germination from 80% to 58%.

The approximate average germination after 6 hours' exposure to different temperatures is plotted in Graph No. 14, A.

Effect of chilling :—

Germination was quite good (55%) after 2 hours' chilling. No stimulating effect as to rapidity of germination was observed. By continuous chilling for 6 days the spores lost all their viability. The loss in viability on exposure to low temperatures seemed to be a gradual function up to the critical limit, as shown by Graph No. 14, B.

Effect of sunlight :—

Spores exposed to direct sunlight (glass-filtered) for 15 days showed a reduced germination from 78% to 42%. The spores put in the room at 18.5 to 20°C. temperature for the same time gave a germination of 72%. The germination obtained at 23.5°C. was 64%. When kept for 15 days at this temperature the germination was 50%.

Maturity :—

No germination was obtained on the first 2 days after the appearance of the pustules. On the third day the spores gave 16% germination. The process was slow, as the early stages of germination were not observed for 8 hours. On the 4th and 5th days the germination started normally and was about 50%.

The spores attained the full maturity in about 5 days. From a ten-day pustule the germination was invariably 75% to 80%.

The early spores when detached from the pustule always came out in a mass associated with some of the epidermal tissue. The following germination was obtained on different days.

Room Temperature 18-18.

Date.	Number of days after appearance when examined.	Percentage germination.
15-1-37	1	Nil.
16-1-37	2	Nil.
17-1-37	3	15%
18-1-37	4	50%
19-1-37	5	50%
22-1-37	8	75%
24-1-37	10½	78%

Longevity :—

In this case also the longevity of the uredospores was considerable. The spores from the material collected in September were viable even up to the last week of February. The material kept at lower temperature (5°C.) gave double the germination than the one kept at the room temperature.

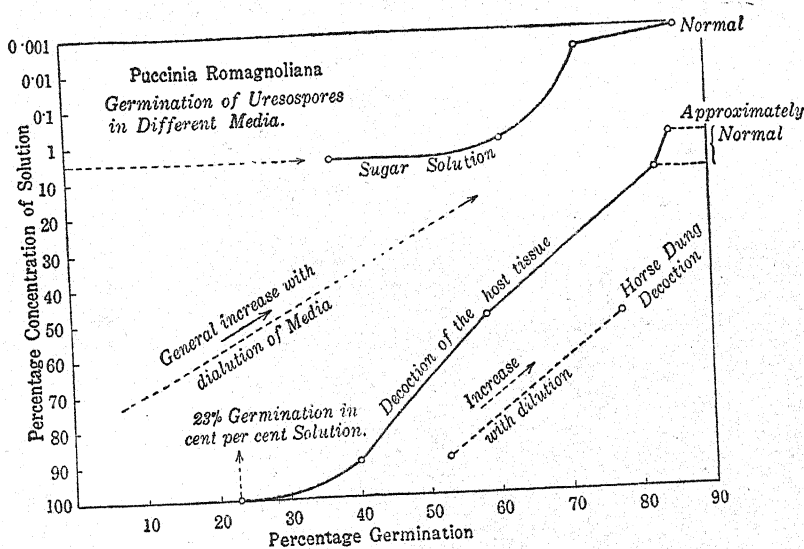
Percentage Germination.

Date on which collected.	Dates on which examined.	From material kept in room.	From material at 5°C.
28-9-36 Initial	7-12-36	43%	68%
Percentage	19-1-37	33%	63%
80%	22-2-37	30%	59%

GERMINATION OF UREDOSPORES IN DIFFERENT MEDIA

Decoction of the host tissue :—

Decoctions were made separately from mature and young leaves as in previous cases. The germination was alike in both cases, but there was no stimulatory action. In higher concentrations the germination was markedly less than that in ordinary distilled water. The gradual increase in germination with dilution is shown in Graph No. 15, A.



Graph No. 15

Horse dung decoction :—

Only 2 concentrations were tried, 90% and 50%. There was no stimulatory action in either. The germination is 90%, concentration was 53% and in 50% concentration it was 78%. The initial percentage was 90% (Graph No. 15, B.).

Sugar solutions :—

The sugar content of the leaves was found to be .003%.

Only 4 concentrations were tried. In solutions of .001 concentration the germination was normal.

In higher concentrations the germination was much less.

There was no effect on the germ tubes (Graph No. 15, C).

Acid solutions :—

The acid content was found to be .00092%. Only copper sulphate solution was tried.

In .001 concentration, only 30% germination was observed. There was no germination in .01% solution.

Spores put in water with a little quantity of powdered sulphur did not germinate.

Ethyl alcohol :—

This stimulated germination, which was quicker and normal but only upto 2% concentration. In a 5% solution the germination came down to 30% and the spores shrivelled up.

TELEUTOSTAGE

In the month of February, teleutospores were found in some cases mixed with the uredospores. Only a few of them were noticed.

They were bicelled, thick-walled structures having a dark brown colour. The stalk was hyaline. The upper cell was slightly bigger than the lower one.

They were 15.7 to 24.9 by 19.3 to 33.9 in size.

On account of their number being very small no attempt could be made to secure their germination.

5. UROMYCES* Sp. on Saccharum Arundinaceum
(Sarpat grass)

This rust was observed early in September. The rusted plants all lay near a water Nala, under a huge tree. The soil was very damp. At this stage plants in other places in the same locality did not show any signs of the disease. Other localities were also visited where these plants were growing but the rust was not found anywhere else. In November, plants of some other plots in the same locality showed fresh pustules, but these plots were not damp as in the previous case. At about the same time, the plants of one or two other localities (Bund Road) showed the appearance of the rust.

Pustules were found on both surfaces of the leaves, arranged longitudinally along the veins. Later on the number of pustules was increased and most of the leaves showed about 50% infection. The pustules were sometimes more than half an inch in length (due to confluence of many pustules).

Uredospores :—

They were 15 to 23.5 μ by 21 to 31.6 μ in size. They were thin walled, sub-globose or globose to ovate in shape. They were yellowish brown in colour. The surface was smooth and 2 germ pores were visible in surface view.

Germination of the uredospores :—

On removing the spores from the leaf to distilled water it was found that a Deutromycete was growing in association with the pustules which superficially resembled the teleuto stage.

* Note.—On this host P. Kuehin has been recorded, which was wrongly taken as Uromyces Kuehin before. The present species is quite a different one and hence no sp. name can be given here.

The germination was very poor, probably due to the presence of the Deutromycete.

The highest germination noted under normal conditions was 8%. Germination at 20°C. was found to be no better.

On November 15th, some newly infected plants were noticed in a different place (in the same locality). In this case there was no infection by the Deutromycete. Under normal conditions 70% of the spores germinated.

Germination tests were made by mixing spores from both the materials, *i.e.*, the one infected with the Deutromycete and the other without it. In all cases the germination hardly exceeded 15%. On the other hand the spores from the material without the Deutromycete gave a germination of about 70%. The following were some of the results obtained in all the 3 cases.

Percentage Germination.

Date.	Spores from material attacked by Deutromycete.	Spores from material free from Deutromycete.	Spores mixed from both.
27-11-36	8%	72%	15%
28-11-36	6%	74%	12%
29-11-36	7%	77%	17%

The germination was, as usual, preceded by the swelling of the spores. The first stages were observed after 2 hours.

The germ tubes showed globular contents separated by vacuoles but the vacuolisation in the spore could not be observed.

18437

Germ tubes :—

The relation of the germ tube to the spore was not clear, as both the epispore and endospore seemed to be in continuation of the germ tubes.

The germ tubes showed a special feature of sending a number of branches at the end. These branches also contained globular contents. Their tips were densely filled and gave a swollen appearance.

Rate of linear increase :—

Observations were made only for 4 hours. The observations were started when the germ tubes were about 15 μ in length. In this case also the germ tubes first showed a slow and then rapid increase in linear growth which continued for 4 hours when the germ tube had attained a size of 678 μ . The next day the germ tubes were found to have branched and it was very difficult to measure their exact lengths.

Teleutostage :—

The teleutostage was found on 14-2-37. The teleutospores were one-celled, thick-walled structure. They were oval, elongated and light brown in colour. The teleutosori were amphigenis and aggregated or solitary.

The stalks were hyaline. The teleutospores were 18.2 to 26 μ by 22.4 to 34.8 μ in size.

In order to secure their germination they were freezed for different times but without success.

6. *UROMYCES GENITILIS* syd. on *Mimusops hexandra* (Khirmi)

This was first described by Sydow and Mitter in 1933 (29). Infected leaves were found in the first week of

LIBRARY OF
EWING CHRISTIAN COLLEGE
ALLAHABAD

October. The highest infection at this stage was about 30%.

The pustules were found on the lower surface of leaves. They were quite big in size and appeared to be superficial. There was no regular arrangement with regard to the veins.

Uredospores :—

They were dark brown to black in colour with various shapes. The wall appeared to be thicker than in other cases met so far. The spores were 16.68 to 31.3 μ by 16 to 21.5 μ in size.

Some of the spores gave a triangular appearance and all sorts of intermediate stages from circular to this shape were found. No germ pore was visible.

Germination of the uredospores :—

This was a rather peculiar case. The spores did not germinate in ordinary distilled water. In a 2% sugar solution, also spores did not give any germination. When freeze-dried for an hour, about 15% germination was obtained. When the spores were exposed to a temperature of 5°C. for 1 hour, about the same number germinated.

The germ tubes were exceptionally small and twisted. Due to the dark colour of the spores the relation of the germ tube to the spore could not be seen. Preparation in lactophenol also did not give any idea about relation of the spore to the germ tube.

Exposure to higher temperatures also did not give any germination. By longer exposures to 5°C., no germination was obtained.

SUMMARY

(1) The work includes a study of 6 different rusts of Allahabad, out of which 4 have been studied in greater detail. The essential features studied were the germination of uredospores, in different conditions, incubation periods, mycelium and the effects of the fungus on the host.

(2) Germination of uredospores always took place by swelling, due to absorption of water.

(3) The germ tube, in most cases, was continuation of the intine.

(4) The rate of development of germ tube was slow in the early stages. This was followed by a rapid rise, and in the end became slow again.

(5) Light had no effect on germination in *Uromyces*, *andropogoni-annulati*, but in others it was found to have an inhibitory action on germination.

(6) Temperature had a great effect on germination; from the optimum to maximum there was a gradual fall in germination and the same was true for the lower limit.

(7) Almost all the rusts had their optimum between 18°C. to 25°C. with a maximum of 35°C. to 40°C.

(8) Germination received no stimulus in decoctions of host tissues and horse dung, and sugar solutions. On the contrary it showed an inhibitory effect. The germination always increased as the dilution of the medium was increased. In *P. penniseti* germination did not take place in cent percent decoction of mature tissue.

(9) Copper sulphate solution proved more toxic than ovalic acid and required a much lesser concentration to inhibit germination.

(10) There was no correlation between sugar and acid content of the leaves and the germination of the uredospores.

(11) Ethyl alcohol in low conc. proved to be a stimulating medium for germination.

(12) The viability of the uredo was considerable in all cases and some of them withstood 6 hours' exposure to 56°—58°C.

(13) Chilling for short periods stimulated the germination in all cases but longer chilling proved detrimental.

(14) No acid, or sugary exudations were detected in the process of the germination.

(15) The longevity of the spores was considerable, exceeding 4 to 5 months and this was enhanced by keeping the material in low temperatures and high humidity.

(16) The spores gave a poor germination in the early stages of the formation of the pustules.

(17) The incubation period was different for every rust, and depended on the environmental conditions and maturity of the host.

(18) The mycelium was always intercellular and haustoria were knob-like.

(19) Germination of teleutospores was secured only in *Puccinia ruelliae* by continuous freezing for 25 days.

(20) The effect of the fungus on the host was universal in all cases, *i.e.*, disappearance of chlorophyll, disorganisation of cells and chloroplasts, and a loss in the sugar content of the leaves.

In the end it is my pleasant duty to thank Dr. J. H. Mitter, at whose suggestion the problem was taken, for his inspiring guidance and special laboratory facilities. I wish to express my thanks to Dr. R. K. Saxena and Mr. R. N. Tandon, for their timely advice and interest in the work. My thanks are also due to Mr. A. K. Mitra and Dr. S. P. Naithani for helping me in the preparation of the photographs.

LITERATURE CITED

- | | | |
|---|------|--|
| (1) Butler, E. J. | 1903 | The Ind. wheat rust prob.
Dept. Agr. Ind. Bill No.
1, Part I. |
| (2) Cunningham, D. D. | | Introductory chapter of (6). |
| (3) Barclay, A. | 1887 | Journ. Asiat. Soc. Bengal,
Part 11, No. 3. |
| (4) Butler, E. J. | 1918 | Fungi and diseases in Plants. |
| (5) Butler, E. J. and
Hayaman, J. M. | 1906 | Mem. Dept. Agric. Ind.
Bot. Ser., Vol. 1, No. 2. |
| (6) Butler, E. J. and
Bisby | 1931 | Fungi of India. |
| (7) Chamberlain, C. J. | | Plant Histology. |
| (8) Saxena, K. L. | 1928 | Fungus flora of Allahabad,
Allahabad University
Studies. |
| (9) Dietel, P. | 1921 | (Page 221) (14). |
| (10) Craigie, J. H. | 1931 | An experimental invest of
sex in the Rust fungi—
Phyto-path., Vol. XXI,
No. 11. |

- | | | |
|--------------------------------------|------|--|
| (11) Rawlins, T. E. | | Phytopathological Bot. Res. methods. |
| (12) Theodore, M. B. | 1937 | Effect of inoculating cereal plants with spores of cereal rusts—Trans. Brit. Myc. Soc. Vol. |
| (13) Seydow, P. and Mitter, J. H. | 1933 | Uromyces genitilis syd.—Ann. Mycologici, Vol. XXXI, No. 1. |
| (14) Arthur, J. C. | 1929 | Plant Rust. |
| *(15) Debary, A. | 1887 | Com. morph. and biol. of the fungimycetozoa and bacteria. Bot. Zeit. 25. |
| *(16) Schneider, W. | 1927 | Centr. Bakt. II, 72. |
| *(17) Duggar, B. M. | 1901 | Phys. studies with ref. to germination of certain fungus spores—Bot. Gaz. 31. |
| *(18) Ward, H. M. | 1902 | Expts. on the effect of min. starvation on the parasitism of the uredine fungus. P. dispersa.—Proc. Roy. Soc. London 71. |
| *(19) Hart, Helen | 1926 | Factors affecting the dev. of M. lini—Phytopath. 16. |
| *(20) Mains, E. B. | 1917 | Rel. of some rusts to the Physio. of their hosts.—Amer. Jour. Bot. 4. |
| *(21) Reed, H. S. and Crabill, C. H. | 1915 | The cedar rust disease of apples—Tech. Bull. Va. Agr. Exp. Sta. 9. |
| *(22) Carleton, M. A. | 1903 | Culture meth. with uredineae—Jour. Apple. Micros. Lab. Meth. 6. |
| *(23) Spaulding, P. | 1911 | Blister Rust of white pine—Bull. Us. Dep. Agr. Bur. Pl. Indus, 206. |
| *(24) Stevens, F. L. | 1898 | Effect of aq. sol. on germination of fungus spores—Bot. Gaz. 26. |

* Original literature was not available, reference was seen in (14) and others.

- | | | |
|--|------|---|
| * (25) Carleton, M. A. | 1893 | Studies in Biol. of uredineae, I notes on germination—Bot. Gaz. 18. |
| * (26) Hursh. | 1922 | Rel. of temp. & H. ion. conc. to uredo germination of biol. forms of stem rust of wheat Phytopath. 12. |
| * (27) Greany, F. J. | 1928 | Studies in the toxicity and fungicidal efficiency of sulphur dust in the control of some cereal rusts—Sci. Agri. 8. |
| * (28) Doran, W. L. | 1919 | The min. opt. max. tem. of spores germination in some uredinales—Phytopath. 9. |
| (28B) Brown, W. | 1922 | Effects on the germination of fungal spores of the volatile substances arising from plant tissues. Ann. of Bot. 1922. |
| * (29) Johnson, E. C. | 1912 | Cardinal temp. for germination of uredospores of cereal rusts Phytopath. 2. |
| (30) Mehta, K. C. | 1923 | Some obs. regarding the recurrence of cereal rusts in the neighbourhood of Cambridge. Trans. Brit. Myc. Soc. 18. |
| * (31) Johnson, E. C. and Freeman, E. M. | 1911 | The rusts of grains in the United States—Bull. Bur. Pl. Indus. 216. |
| * (32) Hoerner, G. R. | 1921 | Germination of aecio. uredo, and telio-spores of <i>P. coronata</i> Bot. Gaz. 72. |
| * (33) Maneval, W. E. | 1927 | Further germ. tests with teliospores of rusts—Phytopath. 17. |
| * (34) Duff, G. H. | 1918 | Some factors affecting viability of uredospores of <i>cronartium riicola</i> . Phytopath. 8. |

* Original literature was not available, reference was seen in (14) and others.

- | | | |
|--|------|---|
| (35) Weston, D. | 1931 | Effect of light on germination of <i>P. graminis</i> —Nature 38. |
| (36) Eriksson, J. | 1895 | Centr. Bakt. II. |
| (37) Mehta, K. C. | 1929 | Annual recurrence of rusts on wheat in India. Presid. address 16th Ind. Sci. Congress, Madras. |
| *(38) Melhus, I. E. and Durrel, L. W. | 1919 | Studies on the crown rust of oats. Res. Bull. Iowa. Agr. Agr. Exp. Sta. 49 |
| *(39) Doran, W. L. | 1922 | Effect of ext. and int. factors on the germination of fungous spores Bull. Torrey Club 49. |
| *(40) Peltier, G. L. | 1923 | Infection studies with <i>P. graminis tritici</i> form III and IX Res. Bul. Neb. Agr. Exp. Sta. 25. |
| (41) Hart, Helen, and Zalesky | 1935 | Effect of light intensity on rust, Dev. Phytopath. 25. |
| (42) Hart, Helen and Forbes. | 1935 | Rel. of stomata to stem. Rust resistance Phytopath. 25. |
| *(43) Stakman, E. C. and Piemsiel, F. J. | 1917 | Biologic forms of <i>P. graminis</i> on cereals and grasses. Jour. Agri. Res. 10. |
| (44) Mehta, K. C. | 1933 | Rusts of wheat and garley in India, study of their annual recurrence life histories and physiologic form. Ind. Jour. Agri. Sci. Dec. '33. |

EXPLANATION OF PLATES

Uromyces andropogoni annulati:—

- | | |
|--------------|--|
| Plate No. 1. | 1 to 4 Uredospores of various shapes, 5 to 11 different stages of their germination. |
| Plate No. 2. | 1 to 4 Teleutospores, showing hyaline stalks and thick walls. |

* Original literature was not available, reference was seen in (14) and others.

Puccinia ruelliae:—

- Plate No. 3. Germinating teleutospores—A. showing sterigmata (S).
- Plate No. 4. 1—4 uredospores, 5 to 10—different stages in germination.
- Plate No. 5. Section through a young pustule—(M) Mycelium (S) stolon-like hyphae bearing spores (S p)—(G) guard cells. (V) substoratal vesicle.
- Plate No. 6. Section through infected part of the stem. (M) mycelium, (S) spores.

Puccinia penniseti:—

- Plate No. 7. (A) leaf showing uredo pustules.
(B) „ „ teleuto pustules.
- Plate No. 8. 1 Uredospore, 2 to 7—various stages in germination of uredospores. (B) Branching of the germ tubes.
- Plate No. 9. Section through a pustule—showing teleutospore (T) borne on a stolen like hyphae (St). (N) two neclei in a cell.

Puccinia romagnoliana:—

- Plate No. 10. Infected leaves showing the pustules.
- Plate No. 11. Section through a pustule (M) mycelium, (h) haustoria (St) stolen like hapahae bearing the spores (S).
- Plate No. 12. 1 Teleutospores—showing hyaline stalks.
- Plate No. 13. A. 1 uredospore. 2—6 various stages in germination (Br) Branching of germ tube. B. 1—3 Teleutospores. (ap) apex showing greater thickening.

Uromyces genitilis on (*Khiri*):—

- Plate No. 14. Uredospore and some stages in germination. 6—shows the twisted and small germ tube.

FLORA OF ALLAHABAD

PART II

BY

G. D. SRIVASTAVA, M.Sc.,

Department of Botany, University of Allahabad.

(Continued from Volume XIV, 1938, page 133.)

In addition to the references given in Part I, the following have also been consulted:—

Dudgeon, W. ... A Contribution to the Ecology of the Upper Gangetic Plain. *Journ. Ind. Bot.*, Vol. I, 1920.

Raizada, M. B. ... Plants of the Upper Gangetic Plain. *Journ. Ind. Bot. Soc.*, Vol. XV, 1936.

XLVII. RUBIACEAE

Oldenlandia, Linn.

A slender erect or diffuse, di- or trichotomously branched herb. Leaves usually small, narrow. Flowers small, white in di-chotomous cymes. Calyx-teeth 4, rarely 5, usually erect, distant in fruit. Corolla rotate or funnel-shaped, lobes 4 or 5, valvate. Ovary 2-celled, ovules numerous, style filiform, stigmas 2, linear. Capsule small, terete or angled, many-seeded.

Oldenlandia corymbosa, Linn. *Fl. Brit. Ind. III*, p. 64.

A herb up to 1 ft., but often straggling. Leaves sessile, 1-2" long, linear-lanceolate. Peduncles axillary, solitary, shorter than the leaves, usually 2-3 flowered. Calyx-teeth subulate, nearly equalling the tube when in flower. Corolla-tube short, white. Capsule globose, narrowed to the base.

Flowers during the rainy season.

Oldenlandia diffusa, *Roxb. Fl. Brit. Ind. III*, p. 65.

A plant very much like the previous one and cannot be easily distinguished. Flowers are usually solitary and sessile.

Flowers during the rainy season.

Morinda tinctoria, *Roxb. Fl. Brit. Ind. III*, p. 156.

Vern. *Al.*

A small tree with 4-angled branches. Leaves 4—8" long, elliptic, tomentose on both surfaces, stipules often bifid. Peduncles leaf-opposed. Flowers in globose heads, 5-merous, white. Corolla-tube 1" long. Fruit about 1" in diameter, composed of many coalescent drupes.

Flowers: April—September.

Spermacoce, *Linn.*

Herbs, branches usually square. Leaves opposite. Flowers small, solitary or in axillary cymes. Calyx-teeth 2—4. Corolla-lobes 2—4, infundibuliform. Stamens 4. Ovary 2-celled, 1 ovule in each cell.

Spermacoce stricta, *Linn. Fl. Brit. Ind. III*, p. 200.

Erect annual. Leaves 1-2" long, linear to ovate, acute, coriaceous, margins often recurved, stipule with many long bristles. Flowers many, in globose compact heads. Corolla white. Capsule 1/8" long, narrowed to the base, carpels dehiscent ventrally.

Flowers during the rainy season.

Spermacoce hispida, *Linn. Fl. Brit. Ind. III*, p. 200.

A procumbent herb with hairy stems. Flowers 4—6 in a whorl, shortly pedicelled. Corolla pink or white. Capsule 1/5" long, rounded at the base, one carpel dehiscent ventrally, the other remaining indehiscent.

Flowers during the rainy season.

**Ixora coccinea*, Linn. *Fl. Brit. Ind. III*, p. 145.

A small shrub. Leaves opposite, stipulate, 2—4" long. Flowers in cymes. Calyx 4-toothed. Corolla-tube long, slender, 4-lobed, twisted, spreading. Stamens 4, at the mouth, filaments short. Ovary 2-celled, ovule solitary in each cell.

Flowers: May—September.

**Anthocephalus indicus*, A. Rich. *Fl. Brit. Ind. III*, p. 23. Vern. *Kadam*.

A large handsome deciduous tree. The flowers are large, yellow, in globose heads.

Flowers during the rainy season.

**Mussaenda frondosa*, Linn. *Duthie. Fl. I*, p. 432.

It is very much grown in the gardens as an ornamental shrub. The yellow flowers are conspicuous due to the development of one of the calyx-lobe of each flower into yellowish membranous leaf.

Flowers: November—January.

**Hamelia patens*, Jacq. *Duthie. Fl. I*, p. 432.

It is often grown in the gardens of Upper India. It is a handsome evergreen shrub, with reddish flowers, arranged in helicoid cymes.

Flowers: July—February.

**Catesbea spinosa*, Linn.

A tall spiny shrub with pale yellow pendulous flowers.

XLVIII. COMPOSITAE

Vernonia, Schreb.

Herbs. Leaves alternate. Heads terminal, homogamous. Involucre of bracts equalling or shorter than the flowers, in many series, inner longest. Receptacle

naked. Flowers all tubular, bisexual, never yellow. Corolla-lobes 5, purple. Achenes ribbed or angled. Pappus of many hairs or bristles.

Vernonia cinerascens, *Schultz-Bip. Fl. Brit. Ind. III*, p. 237.

A low woody much branched herb, clothed with grey hairs. Leaves sessile $\frac{1}{2}$ — $1\frac{1}{2}$ " long, spatulate, entire. Heads $\frac{1}{4}$ " in diameter, purple. Achenes ribbed, hispid.

Flowers: October—April.

Vernonia cinerea, *Linn. Fl. Brit. Ind. III*, p. 233.

An erect rarely decumbent herb, more or less pubescent. Leaves shortly petioled, 3" long, ovate, crenate or serrate, hairy on both sides. Heads $\frac{1}{4}$ " in diameter. Achenes not-ribbed, pubescent.

Flowers: December—March.

Ageratum conyzoides, *Linn. Fl. Brit. Ind. III*, p. 243.

A soft hairy annual. Leaves opposite or the upper alternate, petiolate, ovate, crenate. Heads homogamous, arranged in dense terminal corymbs. Flowers many. Corolla pale-blue or white, all tubular, limb 5-cleft. Achenes angled, black. Pappus of 5 short free or connate scales.

Flowers: January—March.

Centipeda orbicularis, *Lour. Fl. Brit. Ind. III*, p. 317.

Vern. *Nakchikni*.

A prostrate glabrous woolly annual. Stems spreading from the root. Leaves alternate, toothed. Heads heterogamous, small. Ray-florets female, many seriate, yellow, ligulate. Disc-florets bisexual, few. Corolla-tube 4-fid. Achenes 4-angled, hairy, hairs sometimes hooked, pappus absent.

Flowers: February—April.

Blumea, DC.

Annual or perennial, glandular-pubescent or woolly herbs. Leaves alternate, toothed or lobed. Heads corymbose, paniced, heterogamous. Flowers purple or yellow. Ray-florets many-seriate, female. Disc-florets, hermaphrodite, few, tubular, limb 5-toothed. Receptacle flat, naked. Achenes small, pappus 1-seriate.

Blumea wightiana, DC. *Fl. Brit. Ind. III*, p. 261.

An erect villous herb, very leafy. Leaves petiolate, 2" long, ovate or obovate, lanceolate, serrate. Heads many, $\frac{1}{4}$ " in diameter. Corolla purple. Achenes terete or angled, hairy.

A common weed. Flowers: February—May.

Blumea lacera, DC. *Fl. Brit. Ind. III*, p. 263.

An erect annual, usually glandular-pubescent and with a strong scent of turpentine. Stem very leafy. Leaves sessile, or lower petioled, oval or ovate, dentate or serrate, silky on both the surfaces. Heads $\frac{1}{3}$ " in diameter. Flowers yellow. Achenes 4-gonous, glabrous.

A common weed. Flowers: February—June.

Blumea membranacea, DC. *Prod. Fl. Brit. Ind. III*, p. 265.

A slender glandular-pubescent annual. Stem 2—4 ft. high. Leaves thinly membranous, the lower petioled, $5\frac{1}{2}$ " long, obovate, lyrate. Heads many, $\frac{1}{4}$ " in diameter. Flowers yellow. Achenes hairy.

A common weed.

Pluchea lanceolata, Oliv. *Fl. Brit. Ind. III*, p. 272.

A small hoary pubescent annual herb with erect branches. Leaves coriaceous, sessile, 1-2", narrowed to the base, minutely pilose. Heads in compound corymbs,

heterogamous, usually tinged with purple. Achenes minute, pappus connate at the base.

Flowers: February—April.

Gnaphalium, Linn.

Hoary or woolly herbs. Leaves alternate, entire. Heads small, heterogamous. Flowers all fertile, outer female, disc-florets hermaphrodite. Receptacle pitted. Achenes oblong, not-ribbed. Pappus 1-seriate.

Gnaphalium luteo-album, Linn. Fl. Brit. Ind. III, p. 288.

A very variable woolly annual, 4—18" high. Leaves sessile, 1-2" long, woolly on both the surfaces, upper lanceolate, acute, half-amplexicaul. Heads leafless, whitish-yellow, arranged in dense corymbose clusters. Achenes papillose, shorter than the involucre.

Flowers: March—May.

Gnaphalium indicum, Linn. Fl. Brit. Ind. III, p. 289.

A slender weed more or less clothed with white wool. Stem 6—12" high, leafy. Leaves $\frac{1}{2}$ —1 $\frac{1}{2}$ " long, spatulate, woolly on both the surfaces. Heads $\frac{1}{8}$ " in diameter, simple or branched leafy spike. Achenes papillose. Pappus-hairs not coherent at the base.

Flowers: February—April.

Gnaphalium pulvinatum, Delile. Fl. Brit. Ind. III, p. 289.

A woolly annual, stem spreading from the root, prostrate. Leaves small, crowded at the tips. Flowers minute, immersed in the terminal leaves. Corolla yellow.

Flowers: January-February.

Caesulia axillaris, Roxb. Fl. Brit. Ind. III, p. 291.

A glabrous marshy herb, prostrate or erect. Leaves alternate, sessile, 2—6" long, lanceolate, acuminate, tapering to the auricled base, remotely serrulate. Heads

axillary, sessile. Flowers all hermaphrodite, tubular, pale-blue or white. Involucre large, membranous, bracts 2, ovate. Achenes flat, obovoid, winged on each side. Pappus of 2 ovate scales.

Flowers: November—February.

Inula indica, *Linn. Fl. Brit. Ind. III*, p. 297.

Annual herb. Leaves radical, alternate, 1-2", lanceolate, entire or serrate. Heads solitary, heterogamous. Ray-florets female, yellow. Disc-florets hermaphrodite, tubular, yellow. Achenes ribbed. Pappus 1-2 seriate.

Flowers: March—May.

Pulicaria crispa, *Schultz-Bip. Fl. Brit. Ind. III*, p. 299.

Perennial and woolly herb. Leaves half-amplaxicaul, $\frac{1}{2}$ —1 $\frac{1}{2}$ " long, linear, margins recurved, dentate, undulate, woolly. Heads solitary, heterogamous, yellow. Ray-florets female, 1-2 seriate. Disc-florets hermaphrodite. Pappus-hairs connate at the base in a ring, three times as long as the achenes.

Flowers: February—April.

Xanthium strumarium, *Linn. Fl. Brit. Ind. III*, p. 303.

A coarse unarmed herb. Leaves alternate, toothed or lobed, 2-3" long. Heads monoecious (female and hermaphrodite), axillary. Hermaphrodite heads in the upper axils, globose, many flowered, many sterile, tubular, 5-toothed. Female-heads 2-flowered, fertile, apetalous. Involucre of hermaphrodite heads short, bracts few, 1-2 seriate, narrow. Involucre of female heads with bracts united into an ovoid 2-beaked herbaceous 2-celled utricle, with one female flower in each cell, clothed with hooked bristles. Stamens monadelphous. Pappus absent.

Flowers: February—April.

Siegesbeckia orientalis, *Linn. Fl. Brit. Ind. III*, p. 304.

A large erect pubescent annual. Leaves opposite, petiolate, 1—5" long, toothed. Heads heterogamous, white. Ray-florets female, 1-seriate, fertile, limb 2-3 fid. Disc-florets hermaphrodite, fertile, tubular. Receptacle small, palaea membranous. Pappus absent.

Flowers during the rainy season.

Eclipta erecta, *Linn. Fl. Brit. Ind. III*, p. 304.

A strigose slender weed. Stems erect or prostrate, often rooting at the nodes. Leaves opposite, sessile, 1—4" long, linear, narrowed at both ends, serrate. Heads small, heterogamous. Ray-florets female, 2-seriate, fertile, ligules small, white. Disc-florets hermaphrodite, fertile, tubular. Receptacle flat. Achenes with two of the angles winged. Pappus absent.

Flowers throughout the year.

Bidens pilosa, *Linn. Fl. Brit. Ind. III*, p. 309.

An erect pubescent annual. Stems 4-angled, grooved, thickened at the nodes. Leaves opposite, entire or toothed, very variable, 3-fid or foliate, the terminal segments ovate, serrate. Heads heterogamous or homogamous. Ray-florets, if present, female or neuter, 1-seriate, ligule spreading, yellow or white. Disc-florets, hermaphrodite, fertile, tubular, 5-fid. Achenes long, slender, 4-angled, glabrous, black, exceeding the involucre. Pappus-awns spreading yellow.

Flowers: September—December.

Tridax procumbens, *Linn. Fl. Brit. Ind. III*, p. 311.

A straggling perennial hispid herb, 1-2 ft. high. Leaves few, opposite, pinnatisect, petiolate, 1-2" long, ovate or lanceolate, clothed on both sides with bulbous-based hairs. Peduncles often 1 ft. long, solitary, slender.

Heads heterogamous. Ray-florets female, fertile, ligulate, yellow, 3-partite. Disc-florets hermaphrodite, tubular, 5-fid. Receptacle flat. Achenes silky. Pappus of short or long feathery bristles.

Flowers during the greater part of the year.

Echinops echinatus, *Roxb. Fl. Brit. Ind. III*, p. 358.

Vern. *Gokru* (*Globe thistle*).

A much branched spreading rigid annual, 1—3 ft. high. Stem clothed with white hairs. Leaves alternate, sessile, 3—5" long, oblong, pinnatifid, the lobes ending in spines. Heads in globose involucrate balls (compound head), blue or white, sessile, 1-flowered. Involucre of each head surrounded by strong white pappus-like bristles, one or two often produced into long sharp spines. Achenes elongate, densely silky. Pappus-crown of many short free or connate bristles.

Flowers during the summer season.

Cnicus arvensis, *Hoffm. Fl. Brit. Ind. III*, p. 362.

An erect leafy herb. Stems many from the perennial creeping root. Leaves alternate, often decurrent, 3—5" long, linear, oblong, serrate, lobes spinescent. Heads solitary, long peduncled, homogamous. Outer involucre of bracts ending in short spines. Flowers all hermaphrodite, fertile, tubular, 5-fid. Corolla dull-purple. Achenes 4-angled, smooth. Pappus feathery, copious, light-brown.

Flowers: February—May.

Lactuca, *Linn.*

Glabrous or hispid herbs with milky juice. Leaves radical, alternate, entire or toothed, cauline often stem-clasped and auricled. Heads sessile or peduncled, homogamous, yellow. Flowers all ligulate. Receptacle flat. Achenes compressed. Pappus copious.

***Lactuca runcinata*, Dc. *Fl. Brit. Ind. III*, p. 405.**

A tall annual herb, 1—4 ft. high. Stem hollow below, much branched. Leaves sessile, runcinate-pinnatifid, membranous, radical leaves 6—12" long, cauline half-amplexicaul, auricled. Flowers yellow, ligulate.

Flowers: October—December.

****Lactuca sativa*, Linn. *Kashyap. Fl. Lahore*, p. 153 (the garden lettuce).**

***Sonchus arvensis*, Linn. *Fl. Brit. Ind. III*, p. 414.**

A perennial milky herb with a creeping rootstock. Stem 2—4 ft. high, angular, glandular hairy. Leaves mostly radical, alternate, spinous toothed, cauline amplexicaul, with appressed rounded auricles. Heads terminal, umbellate, yellow, homogamous, 1-2" in diameter, peduncle and involucre of bracts glandular hairy. Flowers all ligulate. Receptacle flat, naked. Achenes narrow, slightly compressed, prominently ribbed on each face and transversely rugose. Pappus copious and hairy.

Flowers during the cold season.

***Launaea*, Cass.**

Perennial glabrous herbs, often with yellow juice. Leaves mostly radical, sinuate-lobed, margins often spinulose-toothed. Heads homogamous; peduncled, racemose, solitary or in fascicles, yellow. Flowers all ligulate. Involucre of bracts many seriate, herbaceous. Receptacle flat, naked. Achenes narrow, flattened. Pappus copious.

***Launaea aspleniifolia*, Hook. *Fl. Brit. Ind. III*, p. 415.**

Perennial glabrous herb. Leaves sessile, 3—6" long, narrowly obovate, lobes minutely toothed, cauline leaves few. Flowering stem 6—18" long, many from the root, almost flaked. Heads $\frac{1}{2}$ " in diameter. Involucre of bracts

glabrous, outer small, linear. Achenes $1/12''$, columnar, angled and ribbed, rib rough, Pappus $1/3''$, hairy.

Flowers: February—July.

Launaea nudicaulis, *Hook. Fl. Brit. Ind. III*, p. 416.

Glabrous perennial herb with yellow juice. Flowering stem many, 6—24" long, spreading on all sides, simple or branched, naked or with few small leaves below the clusters of flowers. Leaves sessile, 2—10" long, pinnatifid, sharply toothed. Heads $\frac{1}{2}''$ long, sessile, narrow in terminal clusters, rarely solitary. Pedicels scaly with small bracts, involucre of bracts overtopping the pappus. Achenes thickly ribbed, much shorter than the pappus.

Flowers during the cold season.

A large number of plants belonging to this family are grown in the gardens for ornamental purposes.

XLIX. CAMPANULACEAE.

Sphenoclea zeylanica, *Gaertn. Fl. Brit. Ind. III*, p. 438.

An erect annual, 1—3 ft. high, glabrous. Leaves alternate, lanceolate, entire. Spikes dense flowered, terminal. Flowers small, sessile, bracteate, greenish-yellow. Calyx slightly inferior, 5-fid, corolla campanulate, 5-lobed, epigynous. Stamens 5, epipetalous. Ovary 2-celled, ovules many, stigma 2-lobed.

Flowers: October—December.

L. PLUMBAGINACEAE

Plumbago, *Linn.*

Perennial herbs, often scandent. Leaves alternate, auricled and amplexicauled. Flowers in terminal spikes, bracts and bracteoles shorter than the calyx. Calyx tubular, covered with stalked glands, limb 5-fid. Corolla-tube long, slender, lobes 5, rounded. Stamens 5 free,

filaments linear, dilated at the base. Ovary narrowed towards the apex, style slender, divided above into 5 branches. Capsule membranous, circumsciss near the base.

Plumbago zeylanica, *Linn. Fl. Brit. Ind. III*, p. 480.
Vern. *Chitra*.

A subsucculent perennial herb. Leaves shortly petiolated up to 4" long. Flowers white.

Flowers: November—January.

***Plumbago capensis**, *Thunb. Duthie. Fl. II*, p. 2.

A native of South Africa has pale-blue flowers and the leaves are arranged in whorls.

LI. PRIMULACEAE

Anagallis arvensis, *Linn. Fl. Brit. Ind. III*, p. 506.

An erect glabrous annual, branching from the base. Branches quadrangular. Leaves opposite, entire, sessile, up to 1" long, ovate, cordate, acute, gland-dotted. Flowers solitary, axillary, pedicelled. Pedicels 1-2" long, erect in flowers, decurved in fruit. Flowers blue. Calyx 5-partite. Corolla $\frac{1}{2}$ " in diameter, a little shorter than the calyx. Stamens 5, attached to the base of the corolla, villous. Ovary globose, ovules many, on free central placenta. Capsule globose, circumsciss. Seeds many.

Flowers during the later part of the cold season.

LII. MYRSINACEAE

***Ardisia humilis**, *Vahl. Duthie. Fl. II*, p. 10.

A small sea-coast shrub. Leaves sessile. Flowers bisexual, rose-coloured, in terminal compound racemes, bracts small, deciduous. Calyx 5-lobed, imbricate. Corolla 5-partite, segments twisted to the right. Stamens 5, filaments free. Anthers sagittate. Fruit globose.

Flowers: November-December.

LIII. SAPOTACEAE

Bassia latuifolia, *Roxb. Fl. Brit. Ind. III*, p. 544. Vern. *Mahua*.

A large deciduous tree with milky juice. Leaves clustered at the ends of the branches, 5—9" long, elliptic, obovate, coriaceous, stipulate. Flowers in clusters at the end of the branches, drooping, rusty tomentose. Calyx-segments 4, in two series, divided nearly to the base, the two outer lobes valvate and enclosing the inner. Corolla campanulate, lobes 8—10, contorted in bud, cream-coloured, fleshy. Stamens at least twice as many as the corolla-lobes, 16—20, anthers in 3 series, sessile, acuminate, connective often produced. Ovary 6—8 celled, villous, fleshy, style 1" or more in length. Fruit a berry, 4-seeded.

The tree flowers during March and April before the new leaves appear.

Mimusops, *Linn.*

Trees with milky juice. Leaves coriaceous. Flowers axillary, solitary or in fascicles. Calyx-segments 6—8, in 2 series, outer-segments valvate, enclosing the inner imbricate segments. Corolla-tube short, lobes 18 or 24 in two or three series. Stamens 6—8, inserted near the base of the corolla and opposite to the lobes of the inner series, filaments short, staminodes as many as the stamens, alternate with those of the same series or connate with them at the base. Ovary 6—8 celled. Fruit globose, 1-seeded.

Mimusops hexandra, *Roxb. Fl. Brit. Ind. III*, p. 549. Vern. *Khirni*.

A handsome evergreen tree. Leaves 2—4" long, obvate-oblong, coriaceous. Flowers white, axillary. Corolla-lobes 18, in two series, the 6 inner ones oblanceolate, the 12 outer linear. Stamens 6, staminodes 6,

alternate with stamens. Ovary 12-celled, hairy. Fruit a berry, 1-seeded, reddish-yellow when ripe.

Flowers: November-December.

***Mimusops elengi**, *Linn. Fl. Brit. Ind. III*, p. 548. Vern. *Mulsari*.

A large very ornamental glabrous evergreen tree. Calyx-segments 8. Stamens 8. The red fruit is eaten.

Flowers: March-April.

LIV. EBENACEAE

***Diospyros cordifolia**, *Roxb. Fl. Brit. Ind. III*, p. 564.

A small tree. Leaves oblong, obtuse. Flowers unisexual. Male flowers axillary. Calyx lobed. Corolla tubular, dull-white. Stamens 4. Female flowers solitary, staminodes 12. Ovary globose, 4—10 celled. Fruit yellow when ripe.

Flowers: April-May.

LV. OLEACEAE

Jasminum, *Linn.*

Shrubs erect or scandent. Leaves opposite, rarely alternate, simple, 3-foliate or imparipinnate. Flowers usually fragrant, arranged in terminal or axillary cymes. Calyx 4—9 fid. Corolla salver-shaped, white-pink or yellow, tube narrow, lobes 4—10, imbricate. Stamens 2. Ovary 2-celled, stigma 2-lobed, ovules 2 in each cell. Fruit a berry, didymous.

Jasminum pubescens, *Willd. Fl. Brit. Ind. III*, p. 592. Vern. *Chameli*.

A scandent shrub. Leaves opposite, simple. Flowers fragrant in dense terminal cymes.

Flowers: March—July.

**Jasminum arborescens*, *Roxb. Fl. Brit. Ind. III*, p. 594.
Vern. *Bela*.

**Jasminum sambac*, *Ait.* Vern. *Motiya*.

**Jasminum*, *humile*, *Linn.*

**Jasminum officinale*, *Linn.*

**Jasminum grandiflorum*, *Linn.*

Nyctanthes arbor-tristis, *Linn. Fl. Brit. Ind. III*, p. 603.
Vern. *Harsinghar*.

A small tree with rough 4-angular branches. Leaves petiolate, 4" long, ovate, upper surface scabrous with bulbous-based hairs pubescent beneath, margin slightly recurved. Flowers very fragrant. Corolla salver-shaped, tube cylindric, orange-coloured, lobes 4—8, imbricate, spreading, white. Anthers 2. Ovary 2-celled, 1 ovule in each cell. Fruit a capsule.

Flowers: August—October.

LVI. SALVADORACEAE

**Salvadora persica*, *Linn. Fl. Brit. Ind. III*, p. 619.
Vern. *Kharjal*.

An evergreen shrub, unarmed. Leaves fleshy, pale-green, glaucous. Flowers greenish yellow, in axillary or terminal panicles. Calyx campanulate, 4-fid. Corolla campanulate, tube short, lobes 4, twice as long as the calyx. Stamens 4. Disc of 4 scales or glands, alternating with filaments. Ovary 1-celled, ovule solitary, erect. Drupe red.

Flowers: November—May.

LVII. APOCYNACEAE

Carissa, *Linn.*

Spinous densely branching shrubs. Leaves opposite, coriaceous. Flowers sessile, white, often tinged with

pink, arranged in lax terminal 3-chotomous cymes. Calyx 5-partite, lobes acute. Corolla salver-shaped, lobes overlapping to the right. Stamens 5, included. Ovary entire 2-celled, ovules 1—4 in each cell. Fruit a globose berry.

Carissa carandas, *Linn. Fl. Brit. Ind. III*, p. 630. Vern. *Karaunda*.

A large erect evergreen shrub. Branches usually alternate, armed at their bases with a pair of stout spines, 1-1½" long. Leaves shortly petioled. Flowers whitish or pinkish. Fruit a berry, 4 or more-seeded, ellipsoid, smooth, purplish when ripe.

Flowers: January—April.

Carissa spinarum, *Linn. Fl. Brit. Ind. III*, p. 631.

A small evergreen shrub. Leaves smaller than those of the previous one, usually acute. Flowers scented, white or tinged with pink. Calyx divided up to the base.

Flowers: April—June.

Rauwolfia serpentina, *Benth. Fl. Brit. Ind. III*, p. 632. Vern. *Chota-Chand*.

A small erect glabrous herb, 5 ft. high, with pale-coloured bark. Leaves whorled, 3—7" long, lanceolate, acute, tapering gradually into the petiole, thin, pale beneath. Flowers small, in terminal or 2-3 chotomous cymes. Calyx 5-fid. Corolla salver-shaped, white or pinkish. Pedicels and calyx red. Stamens included, anther cells rounded at the base. Disc large, cup-shaped, entire or lobed. Carpels 2, distinct or connate, ovules 2, in each carpel. Fruit a drupe, 1-seeded, purplish-black when ripe.

Flowers: August—December.

Lochnera, Reichb. (*Vinca* in *Fl. Brit. Ind. III*, p. 640.)

Perennial herbs. Leaves opposite. Flowers axillary, solitary or in pairs, white or pink. Calyx 5-partite, segments subulate. Corolla salver-shaped, tube slender, lobes overlapping to the left. Stamens on the corolla-tube, filaments very short, anthers free from the stigma, 2-lobed at the base. Disc replaced by 2 long linear glands alternating with the carpels. Carpels 2, free. Fruit an etaerio of follicles, cylindric.

Lochnera pusilla, K. Schum. *Fl. Brit. Ind. III*, p. 640.

An erect branched pale-green annual, 6—24" high. Stem and branches 4-angled. Leaves $1\frac{1}{2}$ —3" long, lanceolate, acuminate, tapering to the base. Flowers small, solitary or in pairs. Calyx-lobes small, filiform. Corolla-tube short, white. Follicles $1-1\frac{1}{2}$ " long, slender.

Flowers: October—January.

***Lochnera rosea, Linn. *Fl. Brit. Ind. III*, p. 640.**

A plant similar to the last one, excepting that it is bigger in size and the flowers are either white or pink.

Flowers: November—February.

Alstonia scholaris, R. Br. *Fl. Brit. Ind. III*, p. 642. Vern. *Satian*.

A large evergreen tree with milky juice, up to 60 ft. or more in height. Leaves whorled, in verticels of 4—7, coriaceous, bright green shining above, 3—8" long, oblong-lanceolate. Flowers in corymbose cymes on a stout peduncles, white. Calyx short, 5-lobed. Corolla salver-shaped, throat naked, closed by a ring of reflexed hairs, lobes overlapping to the right or left. Stamens included, anthers free from the stigma. Disc absent. Carpels 2 distinct, style filiform, stigma bifid. Fruit etaerio of two follicles, linear, slender, seeds hairy.

Flowers: December—March.

Ervatamia coronaria, *Stapf. Fl. Brit. Ind. III*, p. 646.
Vern. *Chandni*.

An evergreen glabrous dichotomously branched shrub with silvery-grey bark. Leaves opposite, axillary, stipules distinct, axillary glands, small, 3—6" long, oblanceolate, acuminate, tapering to the base into a short petiole, dark-green, shining above, pale beneath, membranous. Flowers usually showy, in pairs, and arranged in terminal cymes. Calyx small, lobes 5, free or connate at the base, imbricate. Corolla salver-shaped, mouth naked, lobes overlapping to the left. Stamens included, filaments short. Disc absent. Ovary of 2 carpels which sometimes cohere, style long and slender, stigma on a level with the anthers, clavate. Fruit of 2 follicles, 1-2" long. Seeds 3—6 embedded in a red pulpy aril.

Flowers: May—August.

Nerium odorum, *Soland. Fl. Brit. Ind. III*, p. 655. Vern. *Kaner*.

A large evergreen shrub with milky juice. Leaves in threes, shortly stalked, coriaceous, 4—6" long, linear-lanceolate, acuminate. Flowers in terminal racemose cymes, red-rose or white, fragrant. Calyx 5-partite, lobes lanceolate. Corolla funnel-shaped, tube cylindric, with 5 fringed scales on the throat, lobes overlapping to the right. Stamens inserted near the mouth, filaments short, anthers conniving around and adhering to the stigma, tipped with long hairy appendages, each cell produced downwards into a spur-like appendage.

Flowers: March—June.

Trachelospermum fragrans, *Hook. Fl. Brit. Ind. III*, p. 667.

A tall glabrous scandent shrub. Leaves opposite, 3—5" long, ovate thinly coriaceous. Flowers in lax terminal

cymes white, fragrant. Calyx small, 5-partite, glandular within. Corolla salver-shaped, tube $\frac{1}{2}$ " long, dilated round the anthers, lobes 5, overlapping to the right, twisted to the left. Stamens attached above the middle of the tube, filaments short anthers conniving over and above the stigma, cells spurred at the base. Disc of 5 glands. Carpels 2, distinct, many ovuled. Fruit of 2 follicles, slender, 4—9" long.

Flowers: April—August.

**Thevetia neriifolia*, Juss. *Duthie. Fl. II*, p. 42. (Yellow Oleander.)

A native of tropical America, is cultivated in the gardens. An evergreen glabrous shrub with leaves resembling those of oleander, the flowers are bright yellow. The milky juice is poisonous.

Flowers: August—November.

**Plumeria acutifolia*, Poir. *Duthie. Fl. II*, p. 42. Vern. *Gulachin*.

A small soft-wooded tree with thick fleshy and dichotomous branches. The fragrant flowers which open before the leaves have developed, are white with a yellow centre and pink outside.

Flowers during summer season.

LVIII. ASCLEPIADACEAE

Hemidesmus indicus, R. Br. *Fl. Brit. Ind. IV*, p. 5.

A twining prostrate shrub. Leaves opposite, 2—4" long, linear, lanceolate, obtuse, pubescent beneath. Flowers small, in opposite crowded axillary cymes, greenish purple. Calyx 5-partite. Corolla rotate, lobes thick, valvate. Coronal-scales 5, on the throat of the corolla and alternate with its lobes, short, fleshy. Stamens attached

to the base of the corolla-tube, filaments connate at the base, pollen-masses cohering in pairs in each cell. Stigma 5-angled with a flat crown. Follicles divaricate, slender, terete, smooth. Seeds comose.

Flowers during the greater part of the year.

Calotropis, R. Br.

Erect glabrous shrubs or small trees. Leaves opposite, broad. Flowers large, arranged in umbellate cymes. Calyx divided to the base, sepals ovate, glandular within. Corolla broadly campanulate, lobes broad, naked, valvate. Corona of 5 fleshy laterally compressed scales, radiating from the large staminal column. Filaments connate into a tube, anthers short, broad, tipped with membranous inflexed appendages, pollen-masses solitary in each cell, pendulous, waxy. Stigma depressed, 5-angled. Follicles short, turgid, smooth. Seeds comose.

Calotropis gigantea, R. Br. Brit. Ind. IV, p. 17. Vern. Madar or Safed Ak.

A large shrub, 8—10 ft. high. Leaves sessile, thick, 4—8" long, elliptic or obovate-oblong, acute, with narrow cordate base, covered with white hairs. Flowers 1½-2" in diameter, arranged in umbellate cymes. Sepals ovate, acute. Corolla ½-1" in diameter, purplish or white, lobes spreading. Corona-lobes ½" long, hairy, curved on the back, apex rounded. Follicles 3-4" long, recurved, turgid, smooth. Seeds long, flat, comose.

Flowers throughout the year.

Calotropis procera, R. Br. Fl. Brit. Ind. IV, p. 18. Vern. Madar.

A large shrub up to 6 ft. high, very similar in foliage and general appearance to the preceding one. Flowers about 1" across, scented, buds hemispherical. Corolla pink with purple spots, lobes erect. Corona-lobes erect

equalling or exceeding the staminal column, straight, spurred, the apex bifid and without auricles. Follicles and seeds as in *C. gigantea*.

Flowers: March—May.

***Oxystelma esculentum*, R. Br. Fl. Brit. Ind. IV, p. 17.**

A glabrous climbing perennial herb. Stem slender much branched. Leaves thin, pale-green, $1-1\frac{1}{4}$ " long, lanceolate, acute, base cordate. Flowers drooping, 1" across. Calyx-lobes oblong-lanceolate, acute. Corolla rotate, rose-coloured with purple veins. Coronal-scales acuminate. Style apex slightly convex. Follicles glabrous, $2-2\frac{1}{2}$ " long tapering to a point. Seeds many, ovate flat.

Flowers: September—December.

LIX. LOGANIACEAE

***Buddleia asiatica*, Lour. Fl. Brit. Ind. IV, p. 82. Vern. *Dudhia*.**

A large evergreen shrub, young branches tomentose. Leaves opposite, entire, united by a raised stipulary line, $2\frac{1}{2}-6$ " long, lanceolate. Flowers in dense axillary panicles. Calyx campanulate, 4-lobed. Corolla-tube urn-shaped, lobes 4, imbricate. Stamens 4, on the corolla-tube. Ovary 2-celled, style linear, stigma capitate, ovules many in each cell. Capsule septicidally 2-valved.

Flowers: March-April.

LX. GENTIANACEAE

***Enicostema littorale*, Blume. Fl. Brit. Ind. IV, p. 101. Vern. *Chota chireta*.**

An erect perennial herb, 4—20" high. Stems 4-angled. Leaves opposite, sessile, $1-2\frac{1}{2}$ " long, linear. Flowers small, sessile, in whorled clusters, white. Calyx-tube campanulate, lobes 5, lanceolate. Corolla tubular, below

funnel-shaped, lobes 5, small. Stamens 5. Ovary 1-celled, placentas parietal, slightly intruded, style short, stigma capitate, ovules many. Capsule ellipsoid.

Flowers: July—October.

Hoppea dichotoma, Willd. *Fl. Brit. Ind. IV*, p. 100.

A small much branched annual, glabrous herb. Stem 4-angled. Leaves small, opposite, sessile. Flowers in 2-3 cymose cymes. Calyx campanulate, lobes 4, ovate, longer than the corolla. Corolla urceolate, lobes 4. Stamen 1 perfect, 3 sterile. Ovary 1-celled, parietal placentas. Capsule globose.

Flowers: September—November.

Limnanthemum cristatum, Gris. *Fl. Brit. Ind. IV*, p. 131.

Vern. *Chuli*.

An aquatic floating herb, with shorter and slender petiole-like branches. Rhizome short erect. Leaves floating, orbicular, elliptic, deeply cordate, peltate, 2—4" in diameter. Flowers white, pedicellate. Peduncles clustered at the nodes, solitary or in pairs, or on the apparent petiole, close below the leaf blade. Calyx 4—7 partite, lobes induplicate-valvate. Stamens 4—7, filaments short, anthers versatile. Ovary 1-celled, stigma 2-lobed. Capsule $\frac{1}{2}$ " long, breaking irregularly.

Flowers during the summer months.

LXI. BORAGINACEAE

Cordia, Linn.

Trees or shrubs, sometimes subscandent. Leaves alternate, petiolate. Flowers in cymes, spikes or in heads, polygamous (the hermaphrodite flowers fewer than the males) ebracteate. Calyx tubular, accrescent, teeth usually 5, short, unequal. Corolla infundibuliform or campanulate, white or orange, lobes 4—8, spreading. Stamens

4—8, filaments hairy at the base, anthers exserted, sagittate or hastate. Ovary 4-celled, style terminal, long, bipartite, stigma capitate, ovule 1 in each cell. Fruit an ovoid drupe with one fertile seed.

***Cordia myxa*, Linn. Fl. Brit. Ind. IV, p. 136.** Vern. *Lasora*.

A moderate-sized deciduous tree, up to 40—50 ft. high. Leaves alternate, thinly coriaceous, 3—6" long, elliptic, rounded, cordate, entire. Flowers white, usually 5-merous, in large lax terminal and axillary peduncled cymes. Calyx campanulate, irregularly 5-toothed, accrescent. Corolla-tube as long as the calyx, lobes equalling the tube, recurved. Drupe, ovoid, pink, shining.

Flowers: March-April, fruit ripens: May—July.

***Cordia rothii*, Roem. and Sch. Fl. Brit. Ind. IV, p. 138.** Vern. *Gondni*.

A small tree. Leaves opposite, $2\frac{1}{2}$ —4" long, entire, apex rounded. Flowers small, white, 4-androus, in lax terminal or axillary pedunculate cymes. Calyx $\frac{1}{5}$ " long. Corolla $\frac{1}{4}$ " long, lobes 4, reflexed. Fruit a drupe 1" long, 1-seeded, ovoid, yellow when ripe.

Flowers: April—June.

***Heliotropium*, Linn.**

Herbs. Leaves alternate. Flowers small, white, in terminal dichotomous cymes, usually with long scorpioid branches, bracts small or absent. Calyx 5-lobed. Corolla tubular, lobes 5-imbricate. Stamens 5, included, filaments short. Ovary 4-celled, 1 ovule in each cell, style terminal, short, stigma conical. Fruit of 4-mericarps.

***Heliotropium indicum*, Linn. Fl. Brit. Ind. IV, p. 152.**

A diffuse annual, $\frac{1}{2}$ —2 ft. high. Stem stout and slightly succulent, branches clothed with stiff spreading hairs. Leaves alternate, petiolate, 1—4" long, hairy on

both the surfaces, margins undulate, based decurrent. Spikes 2—6" long, ebracteate. Flowers pale-violet.

Flowers: October-November.

Heliotropium eichwaldi, *Steud. Fl. Brit. Ind. IV*, p. 151.

An erect herb, stems and branches clothed with hairs. Leaves 1-1 $\frac{3}{4}$ " long, with bulbous-based hairs. Spike short, ebracteate, in pairs, helicoid at the apex. Calyx 5-partite, hairy on both surfaces.

Flowers: March—June.

Heliotropium strigosum, *Willd. Fl. Brit. Ind. IV*, p. 181.

A small much branched, usually procumbent, strigose, perennial herb. Leaves $\frac{1}{2}$ -1" long, linear. Flowers less than 1/10" long, bracts linear. Calyx-lobes ovate, accrescent. Corolla salver-shaped. Stigma conical.

Flowers: August—October.

Trichodesma indicum, *R. Br. Fl. Brit. Ind. IV*, p. 153.

An annual herb with appressed hairs. Stems diffuse, up to 18" long. Leaves sessile, 1—4" long, ovate, oblong, cordate, upper surface clothed with stiff hairs, seated on flattened circular tubercles. Flowers pale-blue, changing to pink or white. Calyx $\frac{1}{2}$ " long, segments lanceolate, acute, hastate. Corolla $\frac{1}{2}$ " long, infundibuliform, lobes ovate.

Flowers during the winter season.

Cynoglossum denticulatum var. *zeylanica*, *C. B. Clark. Fl. Brit. Ind. IV*, p. 157.

An erect branching annual herb, 1-2 ft. high, clothed with appressed hairs. Leaves 1 $\frac{1}{2}$ —3" long, lanceolate, acute, narrowed towards the base. Flowers distant, pedicellate. Calyx $\frac{1}{8}$ " long, accrescent. Corolla 1/6" long. Mericarps lochidiate all over.

Flowers: October-November.

Arnebia hispidissima, *DC. Fl. Brit. Ind. IV*, p. 176.

A prostrate annual herb, densely clothed all over with long white stiff hairs. Leaves 1-2" long, sessile, entire. Flowers in helicoid cymes, yellow. Stamens 5. Ovary 4-lobed, style gynobasic, stigmas capitate. Scizocarpic fruit of 4 ovoid nutlets.

Flowers: April-May.

LXII. CONVULVULACEAE

Cuscuta reflexa, *Roxb. Fl. Brit. Ind. IV*, p. 225. Vern. *Akas Bel* (Dodder).

Leafless twining parasitic herb, yellow. Stem branched, succulent. Flowers fragrant, 5-merous, pedicellate, bracteate. Calyx divided almost to the base. Corolla white, deciduous, campanulate. Stamens 5, with short filaments. Ovary 2-celled, 4-ovuled, stigmas 2.

Flowers: October—January.

Porana paniculata, *Roxb. Fl. Brit. Ind. IV*, p. 222. Vern. *Bel Kanu* (Bridal creeper).

A large climbing shrub (liana). Leaves and inflorescence clothed with soft grey hairs. Leaves petiolate, 2-4" long, ovate-cordate, acuminate, entire. Flowers small, white, numerous, arranged in large drooping panicles, units of inflorescence are in cymes. Sepals small, three of them enlarging in fruit, membranous. Corolla $\frac{1}{4}$ " long, campanulate. Capsule $\frac{1}{5}$ " long, 1-seeded.

Flowers: October—January.

Evolvulus alsinoides, *Linn. Fl. Brit. Ind. IV*, p. 220.

A much branched diffuse perennial. Leaves sessile, lanceolate, densely clothed with white hairs. Flowers blue, bracts small. Corolla subrotate, $\frac{1}{5}$ " long. Capsule 4-valved, 4-seeded.

Flowers: July—November.

Evolvulus nummularis, *Linn. Raizada. Journ. Ind. Bot. Soc. XV, 1936.*

Herbaceous, leaves with dense hairs, rooting at nodes. Flowers white.

Convolvulus, *Linn.*

Prostrate, twining. Leaves alternate, entire, lobed. Flowers axillary, solitary or in few-flowered cymes. Bracts narrow. Sepals subequal. Corolla campanulate. Stamens included, filaments unequal. Ovary 2-celled, 4-ovuled, stigmas 2, Fruit a 2-celled capsule.

Convolvulus pluricaulis, *Chois. Fl. Brit. Ind. IV, p. 218.*

A perennial herb with woody root stock. Leaves linear, up to $1\frac{1}{4}$ ", upper ones smaller. Flowers solitary or in pairs, sessile. Calyx hairy. Corolla pale-rose, infundibuliform. Capsule globose.

Flowers throughout the year.

Convolvulus arvensis, *Linn. Fl. Brit. Ind. IV, p. 219.*

A glabrous herb. Stem trailing or twining. Leaves petiolate, 1—3" long, ovate, obtuse, entire, hastate. Flowers solitary or axillary cymes. Corolla infundibuliform, $\frac{3}{4}$ " long, pink. Capsule globose.

A common weed of cultivation. Flowers during the cold season.

Merremia, *Dennst.*

Herbs. Leaves entire. Flowers axillary, on long peduncle, solitary or in few-flowered cymes. Sepals subequal, enlarged and thickened in fruit. Corolla infundibuliform or campanulate. Stamens unequal, included or exserted. Ovary 2—4 celled, stigmas 2, globose, ovules 4. Fruit a 4-valved capsule.

Merremia tridentata, *Hallier. Fl. Brit. Ind. IV, p. 205.*

A small perennial herb. Stems elongate, not twining. Leaves sessile $\frac{1}{2}$ —1" long, linear-hastate. Peduncles

1—3 flowered. Corolla $\frac{1}{2}$ " long, yellow. Capsule ovoid, $\frac{1}{6}$ " in diameter, glabrous, 2-celled.

Flowers: October—December.

Merremia emarginata, Hallier, *Fl. Brit. Ind. IV*, p. 206.

A prostrate creeping herb, twining or procumbent. Stems filiform. Leaves $\frac{1}{2}$ — $1\frac{1}{2}$ " broad, reniform, crenate-toothed, rust-coloured. Petiole $\frac{1}{4}$ —1" long. Flowers yellow. Corolla $\frac{1}{4}$ " long. Capsule $\frac{1}{6}$ " long, 2-celled.

Flowers: September-October.

Ipomaea, Linn.

Twining or prostrate herbs. Leaves entire, lobed or divided. Flowers axillary, solitary or in cymes. Sepals ovate, unequal. Ovary 1—3 celled (rarely 4-celled), 4-ovuled. Stigma capitate. Fruit capsule. 4—6 valved.

Ipomaea hispida, R. & S. *Fl. Brit. Ind. IV*, p. 204.

A twining annual. Stem slender, clothed with appressed hairs. Leaves 2—3" long, ovate, acute, hairy on both surfaces, base cordate with rounded lobes. Flowers 2—3" long, bracts small linear. Corolla campanulate pink, $\frac{1}{2}$ — $\frac{2}{3}$ " long. Capsule $\frac{1}{4}$ — $\frac{1}{3}$ ", globose, 2-celled.

Flowers: September-October.

Ipomaea pilosa, Sweet Hort. *Fl. Brit. Ind. IV*, p. 213.

An annual twining herb. Stems pilose with gland-based hairs. Leaves 2—5" long, broadly ovate, acute, entire or deeply 3-lobed hairy above, white-woolly beneath, petiole 2" or more. Flowers in lax cymes, peduncles 1—3" long, pedicels $\frac{1}{4}$ — $\frac{3}{4}$ " long. Corolla purple, infundibuliform, $\frac{1}{4}$ — $\frac{3}{4}$ " long. Capsule $\frac{1}{4}$ — $\frac{1}{3}$ " in diameter, subglobose.

Flowers during the rainy season.

***Ipomaea reptans*, Poir, *Fl. Brit. Ind. IV*, p. 210. Vern. *Nari*.**

An aquatic herb. Stems elongate, trailing on mud and rooting at the nodes or floating, thick, hollow. Leaves 2—6" long, elliptic-oblong, hastate, petiole 1—5" long. Peduncles up to 4" long, 1—5 flowered, pedicels 1-2" long. Corolla 2" long, infundibuliform, pale-rose coloured. Capsule $1\frac{1}{3}$ " long, ovoid, glabrous.

Flowers during the cold season.

***Ipomaea hederacea*, Jacq. *Fl. Brit. Ind. IV*, p. 199. Vern. *Nilkalmi*.**

An annual. Stems twining, sparsely hairy. Leaves 2—5" in diameter, ovate, cordate, more or less deeply 3-lobed, lobes ovate, acuminate, petiole 1—4" long. Peduncles 1—5" flowered, usually shorter than the petioles. Sepals $\frac{1}{2}$ —1" long, hairy. Corolla $1\frac{1}{2}$ —2" long, tubular, infundibuliform, blue tinged with pink. Ovary 3-celled. Capsule $1\frac{1}{3}$ " in diameter, 3-celled, 6-ovuled, ovoid.

Flowers during the rainy season.

***Ipomaea pes-tigridis*, Linn. *Fl. Brit. Ind. IV*, p. 204.**

A twining pubescent herb. Leaves hairy on both surfaces, palmately-lobed, 5—9 lobed, sometimes 3-lobed, occasionally entire, 1—5" long, and about as broad, lobes elliptic, petioles 1—3" long. Flowers 3 or more together in peduncled heads, peduncles 1—3", densely hairy. Sepals $\frac{1}{2}$ " long, lanceolate, acute, hairy, the 2 outer broader. Corolla white or pink. Infundibuliform 1" long. Capsule concealed in the calyx, $\frac{1}{4}$ " in diameter ovoid.

Flowers: September-October.

****Ipomaea batatas*, Lamark. *Fl. Brit. Ind. IV*, p. 202. Vern. *Shakarkand* (Sweet Potato).**

Tuberous roots, red or white in colour. Largely cultivated as vegetable.

**Ipomaea pulchella*, *Roth. Fl. Brit. Ind. IV*, p. 210 (the Railway creeper).

A perennial climber with glabrous palmately 5-lobed leaves, and pale-purple, campanulate flowers. It is a principal decorative plant at many railway stations.

**Argyreia speciosa*, *Sweet. Fl. Brit. Ind. IV*, p. 184.

Vern. *Samandarsokh* (The elephant creeper).

A liana. Stems stout and densely clothed with white tomentum. Leaves 4—12" long, ovate, cordate, acute, glabrous above and persistently white-tomentose beneath. The deep rose-coloured flowers which open during the rainy season are arranged in cymes. Corolla $2\frac{1}{2}$ " long, tubular, infundibuliform.

**Quamoclit phoenicia*, *Chois. Fl. Brit. Ind. IV*, p. 199.

A scandent herb. Leaves petiolate, ovate-cordate, acute.

LXIII. SOLANACEAE

LIBRARY OF

EWING CHRISTIAN COLLEGE

ALLAHABAD

Solanum, *Linn.*

Herbs sometimes scandent, unarmed or prickly. Leaves alternate or subopposed, in unequal pairs, especially in the region of the inflorescence, due to the adnation of the petiole of the bract to the axillary branch, entire, lobed. Flowers in terminal or axillary cymes. Calyx 5 or 10 lobed, persistent. Corolla rotate, tube short, 5-lobed, plicate in bud. Stamens 5, rarely 4 or 6, filaments short, connivent, opening by terminal pores or short slits. Ovary 2-celled, rarely in cultivated forms 3-4 celled. Fruit a globose or elongated berry.

Solanum nigrum, *Linn. Fl. Brit. Ind. IV*, p. 229. Vern. *Makoi*.

An erect glabrous annual, much branched. Leaves petiolate, 1— $3\frac{1}{2}$ " long, ovate, sinuate-toothed. Flowers

small, extra-axillary, drooping. Corolla white, rotate. Berry black or red.

Flowers during the cold season.

Solanum xanthocarpum, *Schrad & Wendl. Fl. Brit. Ind. IV*, p. 236. Vern. *Kateli*.

A very prickly perennial herb, young parts stellately tomentose. Stem woody at the base, branches armed with curved yellow shinning prickles up to $\frac{1}{2}$ " long. Leaves 2—4" long, ovate sinuate, clothed with stellate hairs. Flowers few in extra-axillary cymes. Corolla bluish-purple, 1" in diameter. Berry $\frac{1}{2}$ — $\frac{3}{4}$ ", yellow.

Flowers during the greater part of the year.

***Solanum melongena**, *Linn. Duthie. Fl. II*, p. 126. Vern. *Baigan*.

The plant is more or less prickly. It is largely cultivated in the area.

Flowers chiefly during the cold season.

***Solanum tuberosum**, *Linn. Vern. Alu* (the potato plant).

It is chiefly cultivated within the area from the middle of September to January.

Physalis minima, *Linn. Fl. Brit. Ind. IV*, p. 238. Vern. *Ban tiparya*.

Annual. Stem erect, 6—18" high. Leaves petiolate, thin, 1—1 $\frac{1}{2}$ " long, ovate, acute, sinuate or lobed, petioles about 1" long. Flowers solitary. Calyx-lobes triangular, accrescent. Corolla $\frac{1}{4}$ " long, yellow or with 5 basal spots. Berry $\frac{1}{2}$ " in diameter.

Flowers: May—August.

***Physalis peruviana**, *Linn. Fl. Brit. Ind. IV*, p. 238. Vern. *Tipari*.

A small shrub resembling the previous one but much stouter and with larger flowers and fruits. The plant is

much cultivated and the bright amber coloured fruit is eaten.

Flowers: August—October.

Datura alba, *Nees. Fl. Brit. Ind. IV*, p. 243. Vern. *Dhatura*.

Stem 5-6 ft. high, herbaceous. Leaves petiolate, 6-7" long, ovate, acuminate, unequal at the base. Flowers white-cream, erect, pedicel late. Calyx $1\frac{1}{4}$ " long, deeply 5-toothed. Corolla 5" long, plicate, 5-lobed. Capsule globose, nodding.

Flowers: November—January.

***Nicotiana plumbaginifolia**, *Viv. Fl. Brit. Ind. IV*, p. 246.

An erect branched herb. Leaves 3—7" by $1\frac{1}{2}$ — $4\frac{1}{2}$ ", radical, larger than the cauline, sessile, elliptic-oblong, entire. Flowers purple-white. Calyx $\frac{1}{2}$ " long, cleft to the middle. Corolla-tube long, narrow. Capsule ovoid, conical.

Flowers: February—June.

***Nicotiana tabacum**, *Linn. Fl. Brit. Ind. IV*, p. 245.

Vern. *Tambacco*. (The tobacco plant.)

***Cestrum nocturnum**, *Murray*. (Mexican Jasmine.)

***Lycopersicum esculentum**, *Mill. Fl. Brit. Ind. IV*, p. 523.

Vern. *Vilayati Baigan*. (The tomato.)

***Capsicum annuum**, *Linn*. (The Chilles.)

***Petunia nyctangiflora**, *Juss*.

***Petunia violacea**, *Lindl*.

LXIV. POLEMONIACEAE

***Phlox drummondii**.

Herbs, hairy with opposite leaves. Flowers condensed into involucrate heads, hermaphrodite, regular. Calyx 5, gamo, valvate, persistent. Corolla 5, gamo, tubular.

Stamens 5, inserted at unequal height. Ovary ticcarpcl-
lary, 3-cclcd, many ovules in each cell. Fruit a capsule.

Flowers: January—March.

LXV. SCROPHULARIACEAE

Celsia coromandeliana, *Vahl. Fl. Brit. Ind. IV*, p. 251.

An erect pubescent annual herb. Radical leaves petiolate, crowded, 2—4" long, lyrate-pinnatifid, cauline leaves sessile, oblong ovate, cordate toothed. Flowers in terminal racemes. Calyx 5-fid, imbricate. Corolla rotate, $\frac{1}{2}$ " across, yellow. Stamens 4, didynamous. Ovary 2-celled, many ovules in each cell. Fruit a globose 2-valved capsule.

Flowers: January—March.

Linaria ramosissima, *Wall. Fl. Brit. Ind. IV*, p. 251.

A glabrous herb. Leaves alternate, petiolate, lower 5—7 lobed, upper usually lanceolate. Flowers axillary solitary or terminal raceme. Calyx 5-partite. Corolla, 2-lipped and personate, tube spurred in front at the base, upper-lip erect, 2-lobed, lower spreading, 3-lobed, yellow. Stamens didynamous. Fruit an ovoid 2-celled capsule.

Limnophila racemosa, *Benth. Fl. Brit. Ind. IV*, p. 271.

An aquatic herb, with creeping roots. Upper leaves sessile, opposite or 3-nately whorled, ovate, serrulate, lower leaves multifid and often root-like. Flowers large erect, terminal leafy racemes, 2—4" long. Corolla pale-violet, with yellow tube, $\frac{1}{2}$ " long. Capsule enclosed in a membranous calyx.

Flowers during the rainy season.

Vandellia, *Linn.*

Annual herbs. Leaves opposite, often toothed. Flowers small, axillary, bracteoles none. Calyx-lobes free

or connate. Corolla 2-lipped, tube cylindric, erect, upper-lip outside, lower broader, 3-lobed. Stamens 4, all perfect, 2 posterior included, 2 anterior with arched filaments, appendaged near the base. Ovary 2-celled. Fruit ovoid, 2-valved capsule.

Vandellia crustacea, *Benth. Fl. Brit. Ind. IV*, p. 279.

A glabrous annual, 4—18" high. Stems angular. Leaves shortly petiolate, margins entire. Flowers axillary. Calyx $1/6$ " long, elongating in fruit, 5-ribbed. Corolla $1/2$ " long, purplish-white. Capsule shorter than the calyx.

A common weed within the area. Flowers: October—December.

Vandellia nummularifolia, *Don Prod. Fl. Brit. Ind. IV*, p. 282.

An erect glabrous herb. Leaves sessile, $1/2$ — $3/4$ " long, broadly ovate, obovate, crenate-serrate. Pedicels very slender. Corolla $1/4$ " long, reddish-purple, lower-lip white. Capsule $1/5$ " long, longer than the calyx.

Flowers: September—December.

Bonnaya veronicaefolia, *Spreng, Fl. Brit. Ind. IV*, p. 285.

A decumbent creeping herb. Stem 4-sided. Leaves $1/2$ —2" long, oblong, distantly serrate. Flowers in racemes. Calyx deeply divided. Corolla violet, streaked with purple. Capsule slender, erect, twice as long as the calyx.

A common weed during the rainy and cold season.

Glossostigma spathulatum, *Arn. Fl. Brit. Ind. IV*, p. 288.

A minute tufted herb, found chiefly in wet soil. Leaves $1/4$ " long, spathulate. Pedicels short. Corolla bluish. Stamens 2.

Flowers: September—December.

Scoparia dulcis, *Linn. Fl. Brit. Ind. IV*, p. 289.

A glabrous leafy undershrub. Leaves opposite, 1-2" long, lanceolate, shortly petioled, margins serrate. Flowers many in terminal panicles. Calyx 4-partite. Corolla white, rotate, 1/8" in diameter, throat bearded. Stamens 4. Fruit a globose septicidal capsule.

A common weed. Flowers: March—November.

Herpestis monniera, *H. B. & K.*

A creeping succulent herb. Stem 4—12" long, rooting at nodes. Leaves sessile, 1/4—1" long, spathulate. Flowers axillary and solitary. Corolla 1/3" long, blue or white. Stamens 4, included. Fruit a globose capsule.

Flowers: August-September.

Veronica, *Linn.*

Herbs. Leaves opposite. Flowers blue or purple, solitary or in terminal or axillary racemes. Calyx 4-5 partite. Corolla rotate, lobes 4-5, spreading. Stamens 2, anther-cells confluent at their tips. Ovary 2-celled. Fruit a capsule.

Veronica anagallis, *Linn. Fl. Brit. Ind. IV*, p. 293.

An erect herb. Leaves sessile, 2—6" long, oblong-lanceolate, entire or serrate. Corolla 1/4" across, pale-purple. Capsule compressed.

Flowers in the cold season.

Veronica agrestis, *Linn. Fl. Brit. Ind. IV*, p. 294.

A prostrate annual. Stems 6—18" long. Leaves 1" long, ovate-cordate. Corolla shorter than the sepals, blue or white. Capsule 4—10 seeded.

Flowers during the cold season.

Striga euphrasioides, *Benth. Fl. Brit. Ind. IV*, p. 299.

Very variable in habit, herb, black when dry. A partial root parasite. Leaves sessile. 1-2" long. Flowers

sessile. Calyx campanulate, ribs 15. Corolla white, $\frac{1}{2}$ - $\frac{1}{4}$ " long. Capsule $\frac{1}{4}$ " long.

Flowers during the cold season.

Lindenbergia urticaefolia, *Link & Otto. Fl. Brit. Ind. IV*, p. 262.

An annual, stems 4—10" high, often tufted. Leaves up to 2" long, broadly ovate, crenate-serrate, usually gland-villous on both sides. Flowers shortly pedicelled. Corolla yellow, $\frac{1}{2}$ " long, tube tinged with red purple.

Chiefly found on old walls throughout the year.

***Russelia juncea**, *Zucc.*

A xerophytic herb with much reduced leaves and pendulous green stems. Shoots often with broad leaves. Flowers tubular, zygomorphic and scarlet red.

Flowers during the cold season.

***Torenia cordifolia**, *Roxb. Fl. Brit. Ind. IV*, p. 273.

An erect annual. Stems and branches 4-angled. Leaves $1\frac{1}{2}$ " long, ovate, acute, serrate. Flowers solitary. Corolla $1\frac{1}{2}$ " long, 2-lipped, ovoid, wings not decurrent. Corolla $1\frac{1}{2}$ " long, bluish-purple. Capsule oblong, acute, enclosed in the persistent calyx.

Flowers: August—October.

LXVI. OROBANCHACEAE

Orobanche aegyptiaca, *Pers. Fl. Brit. Ind. IV*, p. 326.

A leafless parasite (total). Stem 4—20" high, bearing only flowers in racemose order. Flowers sessile, bracts half as long as the corolla-tube, lanceolate. Calyx 4-toothed, campanulate. Corolla 1" long, hairy outside, upper portion blue or lilac, whitish below, upper-lip 2-lobed, lower 3-lobed. Stamens didynamous, 4, included, anther-cells equal, parallel. Ovary 1-celled, ovules many on 4 parietal placentas. Fruit a 2-valved capsule.

Common on mustard and brinjal plants.

Flowers during the cold season.

LXVII. LENTIBULARIACEAE

Utricularia stellaris, *Linn. Fl. Brit. Ind. IV*, p. 328.

An insectivorous aquatic herb, rootless, free-floating. Leaves $\frac{1}{2}$ — $1\frac{1}{2}$ " long, in whorls, much divided, each segment with a small bladder with a mouth opening on the inner side only to catch insects. Flowers in racemes, erect, peduncles 1—8" long, suspended by a whorl of spongy floats. Calyx segments equal, enlarged in fruit. Corolla yellow, $\frac{1}{4}$ " across, bilipped, lower-lip spurred. Stamens 2. Ovary superior, 1-celled, ovules many on a free basal placenta. Fruit a globose capsule.

Flowers: July—November.

LXVIII. BIGNONIACEAE

***Millingtonia hortensis**, *Linn. Fl. Brit. Ind. IV*, p. 377.

Vern. *Akas Nim*.

A tall erect tree with corky bark and soft yellowish wood. Leaves compound, bipinnate, 2-3 ft. long. Flowers white, very fragrant, arranged in large panicles which are terminal on the pendent branches.

Flowers in the beginning of the cold season.

***Bignonia venusta**, *Ker. Gawl. Duthie. II*, p. 174.

A large climbing shrub with 3-foliate leaves and large handsome orange-red flowers arranged in dichotomous cymes.

Flowers during the cold season.

***Stenolobium stans**, *Seem. Duthie. II*, p. 174.

A large shrub or a small tree with handsome compound leaves and large flowers.

***Heterophragma adenophyllum**, *Seem. Fl. Brit. Ind. IV*, p. 381.

A handsome tree with large pinnate leaves. Flowers brownish-yellow, densely tomentose. Capsule 1—3 ft. long, twisted.

Flowers: September—December.

***Kigelia pinnata**, *DC. Brandis.*, p. 492.

An ornamental tree with pinnate leaves clustered towards the ends of the branches and large handsome maroon coloured flowers.

***Oroxylum indicum**, *Vent. Fl. Brit. Ind. IV*, p. 378.

Vern. *Arlu*.

A small deciduous tree. Leaves very large, up to 5 ft. long, leaflets 2—4 pairs. Flowers in large erect racemes. Corolla 2-3" long, tube greenish, limb purple. Capsule 1—3 ft. long flat, straight. Seeds long, winged.

Flowers: January—March.

***Jacaranda mimosifolia**, *D. Don*.

A very beautiful tree with foliage resembling that of Acacias or Albizzia except that the leaves are opposite. It bears panicles of beautiful blue flowers.

Flowers: March—May.

LXIX. PEDALIACEAE

Sesamum indicum, *Linn. Fl. Brit. Ind. IV*, p. 387. Vern. *Tili*.

An erect pubescent annual 1-2 ft. high. Leaves oblong or ovate 3—5" long, serrate. Pedicels 1/3" long, solitary. Flowers with a strong unpleasant odour. Corolla 1½", pinkish-purple, 2-lipped. Stamens 4 didynamous. Ovary 2-celled, ovules many in each cell, axile placentation. Capsule 1" long erect, hispid.

Flowers during the winter season.

***Martynia diandra**, *Gloax. Fl. Brit. Ind. IV*, p. 386.

Vern. *Bichu*.

A tall coarse herb. Leaves large opposite, cordate, glutinous. Flowers diandrous, rose-coloured. Fruit large, woody, beaked with strong curved spines.

Flowers during the rains.

LXX. ACANTHACEAE

**Thunbergia grandiflora*, *Roxb. Fl. Brit. Ind. IV*, p. 392.

An extensive climber with large cordate-ovate or angular leaves and blue flowers. The bracteoles have taken up the functions of the calyx which is much reduced. The seeds are not supported on retinacula.

Flowers: September—December.

**Thunbergia alata*, *Boj. Fl. Brit. Ind. IV*, p. 391.

A slender climber. Leaves softly villous, ovate, cordate, petioles usually winged. Flowers yellow or white with a brown eye.

Flowers during the winter season.

Astercantha longifolia *Nees., Fl. Brit. Ind. IV*, p. 408.

Vern. *Talmakhana*.

A stout herb, growing in ditches and swampy ground. Stems fascicled, spinous at the nodes. Leaves narrow, lanceolate, arranged in whorls of 6, the 2 outer of each whorl longer, up to 7" long. Flowers in whorls of 8 at each node. Bracts about 1" long. Calyx deeply 4-partite. Corolla 2-lipped, bluish-purple, upper-lip 2-lobed, lower 3-lobed. Stamens 4, didynamous. Ovary 2-celled, with 4 ovules in each cell. Fruit a compressed capsule.

Ruellia prostrata *Lamk, Var. dejecta. Fl. Brit. Ind. IV*, p. 412.

A small diffuse herb. Stem prostrate. Leaves opposite, entire, ovate or elliptic, $\frac{3}{4}$ —3" long, entire, slightly hairy. Flowers subsessile. Calyx 5-partite. Corolla oblique, lobes twisted to the left, caducous, pale-grey. Stamens didynamous. Ovary 2-celled, 3—10 ovules in each cell. Fruit a cylindric capsule.

Flowers during the rainy season.

**Ruellia tuberosa*, *Duthie, Fl. II*, p. 189.

Daedalacanthus nervosus, *T. Anders. Fl. Brit. Ind. IV*, p. 418.

A perennial herb with angled stems. Leaves opposite, entire, 6—8" long, ovate acuminate. Flowers braceate, in spikes. Calyx 5-lobed whitish. Corolla deep-blue, tube long, lobes twisted to the left. Stamens 2. Ovary 2-celled, 4-ovuled. Fruit a capsule.

Flowers: February-March.

Barleria, *Linn.*

Small shrubs, spinous or unarmed. Leaves opposite, entire. Flowers showy, sessile in lax spikes, bracts and bracteoles large. Calyx deeply 4-partite, segments in opposite pairs, outer pair much larger. Corolla infundibuliform, lobes 5, subequal. Stamens 2, fertile, 2 small rudimentary stamens, and 5th staminode. Ovary with 2 ovules in each cell. Fruit an ovoid capsule, 4 seeded.

Barleria prionitis, *Linn. Fl. Brit. Ind. IV*, p. 482.

A bush, 2—5 ft. high, usually prickly. Stems and branches 4-angled leaves petiolate, 4" long, elliptic, acuminate, bristle-tipped, interpetiolar stipules, $1\frac{1}{4}$ — $1\frac{3}{4}$ " long. Flowers in terminal spikes of cymes. Calyx divided nearly to the base, spine-tipped. Corolla golden-yellow, 2-lipped. Capsule $\frac{3}{4}$ —1" long with a tapering solid base.

Flowers: October—January.

Barleria cristata, *Linn. Fl. Brit. Ind. IV*, p. 488.

A small erect undershrub, branches clothed with yellow appressed hairs. Leaves $2\frac{1}{2}$ —4" long, acuminate acute, tapering to the base, hairy. Flowers terminal spikes. Calyx hairy below. Corolla blue-purple or white, 1 — $1\frac{1}{4}$ " long. Capsule 2-3" long.

Flowers during the winter season.

Barleria strigosa, Willd. *Fl. Brit. Ind. IV*, p. 489.

An unarmed shrub with hairs. Leaves $4\frac{1}{2}$ "—6" long, ovate, acute. Flowers in dense unilateral spikes. Calyx densely strigose. Corolla $1\frac{1}{2}$ "—2" long, blue. Capsule $\frac{3}{4}$ " long, 4 seeded.

Flowers during the winter season.

Justicia, Linn.

Herbs. Leaves opposite, entire. Flowers in spikes. Bracts small, bracteoles narrow. Calyx 4 or 5-partite, segments narrow. Corolla 2-lipped, upper lip 2-lobed, lower 3-lobed, lobes imbricate in bud. Stamens 2, anthers 2-celled, one cell usually higher than the other, the lower with a white spur-like appendage at the base. Ovary 2-celled with 2 ovules in each cell. Fruit an ovoid capsule.

Justicia adhatoda, Linn. *Fl. Brit. Ind. IV*, p. 540. Vern. *Arusa*.

An evergreen gregarious shrub, 4—8 ft. high. Stem with yellowish bark. Leaves 5—8" long, elliptic-lanceolate, acuminate, tapering to the base. Flowers in short dense axillary peduncles, spikes, 1—3" long. Bracts up to 1" long, bracteoles $\frac{3}{4}$ " long, Calyx $1\frac{1}{3}$ — $\frac{3}{4}$ " long, segments equal. Corolla white with pink stripes in the throat, $1\frac{1}{4}$ " long. Anther cells not spurred. Capsule $\frac{3}{4}$ " long.

Flowers chiefly after the rainy season.

Justicia simplex, D. Don. *Prod. Fl. Brit. Ind. IV*, p. 539.

A prostrate herb. Branches 4-angular. Leaves petiolate 1-2" long, ovate, oblong. Flowers in dense axillary and terminal spikes, 1—4" long. Bracts about as long as the calyx. Calyx deeply partite. Corolla pale-purple. Capsule $\frac{1}{4}$ " long, oblong.

Flowers during the winter season.

Justicia quinqueangularis, *Koen. Fl. Brit. Ind. IV*, p. 536.

A slender prostrate herb. Leaves 1—3" long, linear. Spikes 1—5" long, terminal. Bracts as long as the calyx-lobes. Calyx 4-partite. Corolla rose-coloured. Capsule $1\frac{1}{3}$ " long.

Justicia diffusa, *Willd. Fl. Brit. Ind. IV*, p. 538.

A diffuse much branched herb. Leaves 1—2" long, ovate, acute. Flowers in slender axillary terminal spikes, 1—6" long. Bracts shorter than the calyx. Calyx $1\frac{1}{8}$ " long, 4-partite. Corolla 1—6" long, pale-purple. Capsule $1\frac{1}{5}$ " long, oblong.

Peristrophe bicalyculata, *Nees, Fl. Brit. Ind. IV*, p. 554.

Herb, 3-4 ft. high. Leaves 2-3" long, ovate. Flowers in 3-chotomous cymes. Bracts 2-unequal, opposite, bracteoles, 4, smaller. Calyx 5-partite. Corolla pink, 2-lipped, upper lip entire lower 3-lobed. Stamens 2, anthers 2-celled. Ovary with 2 ovules in each cell. Capsule pointed, narrowed below into a stalk.

Flowers during the rainy season.

Rungia, *Nees*.

Erect herbs. Leaves entire. Flowers in dense terminal or axillary unilateral spikes. Bracts in two or four rows, two of these often flowerless. Calyx small, 5-partite. Corolla small 2-lipped. Stamens 2, anthers 2-celled, parallel, with a white basal appendage. Ovary with 2 ovules in each cell. Fruit an ovoid capsule.

Rungia repens, *Nees, Fl. Brit. Ind. IV*, p. 549.

Stems decumbent. Leaves sessile, 1-2" long, lanceolate, acute. Flowers in erect terminal spikes, $1-2\frac{1}{2}$ " long. Bracts uniform, all fertile. Corolla $\frac{1}{4}$ - $\frac{1}{2}$ " long, white, upper-lip emarginate. Capsule $1\frac{1}{5}$ " long.

Flowers: October—March.

Rungia parviflora, *var. pectinata*, *Nees. Fl. Brit. Ind. IV*, p. 550.

A much branched procumbent annual. Leaves $\frac{1}{2}$ — $2\frac{1}{2}$ " long, elliptic, acute. Spike $\frac{1}{4}$ —2" long, unilateral. Calyx small. Corolla white with the blue lines, upper lip entire. Capsule ovoid.

Flowers: September—March.

LXXI. VERBENACEAE

Lantana, *Linn.*

Scandent shrubs, branches 4-angled, sometimes prickly. Leaves opposite, petiolate, crenate, simple. Flowers in condensed racemes, opening centripetally. Calyx small, 4-5 toothed. Corolla-tube slender, 4-5 lobes, spreading. Stamens 4, didynamous, included. Ovary 2-celled with one ovule in each cell. Fruit a drupe.

Lantana indica, *Rowb. Fl. Brit. Ind. IV*, p. 562.

A shrub 3—5 ft. high. Leaves $1\frac{1}{2}$ — $2\frac{1}{2}$ " long, opposite or in whorls of 3, ovate, acute, crenate-serrate. Flowers indorous, yellowish.

Flowers during the greater part of the year.

***Lantana camara**, *Linn. Fl. Brit. Ind. IV*, p. 562.

A large climbing shrub with prickly branches and orange coloured flowers.

Tectona grandis, *Linn. Fl. Brit. Ind. IV*, p. 570. Vern. *Sagun*. (The teak tree).

A large deciduous tree, branches 4-angled, stellately hairy. Leaves 12" long, ovate, entire, lower surface covered with yellowish hairs. Flowers in terminal much branched cymes. Calyx campanulate, accrescent. Corolla white, 5-6 lobed, tube short. Stamens 5 or 6, exserted. Ovary 4-5 celled, 1 ovule in each cell. Fruit a drupe.

Flowers during the rains.

Lippia nodiflora, *Rich. Fl. Brit. Ind. IV*, p. 563.

A widely creeping much branched perennial herb, rooting at nodes. Leaves $\frac{3}{4}$ -1" long, spatulate, entire at the base, serrate at the rounded apex. Flowers sessile, arranged in globose peduncled axillary heads, elongating after flowering. Corolla white, falling off as a calyptra as the fruit ripens. Fruit dry, separating into two 1-seeded parts.

Flowers: July—March.

Vitex, *Linn.*

Shrubs or trees. Leaves opposite, digitately 3-foliate. Flowers in cymes. Calyx campanulate, 3—5 toothed. Corolla small 2-lipped, 5-lobed. Stamens didynamous. Ovary 2—4 celled with 1 ovule in each cell. Fruit a drupe.

Vitex negundo, *Linn. Fl. Brit. Ind. IV*, p. 583. Vern. *Samhalu*.

A small tree. Leaves 3—5 foliate, leaflets lanceolate, entire, white-tomentose beneath. Flowers in peduncled cymes. Corolla lavender-blue.

Flowers: March-April.

***Vitex trifolia**, *Linn. Duthie. Fl. II*, p. 224.

Leaves simple or 3-foliate, closely allied to the preceding one and with larger flowers.

***Verbena chaemaedrifolia**, *Juss.*

Many cultivated varieties in the garden.

***Gmelina asiatica**, *Roxb. Fl. Brit. Ind. IV*, p. 582.

A spinous shrub with bright yellow flowers.

***Holmskioldia sanguinea**, *Retz. Fl. Brit. Ind. IV*, p. 596.

A straggling shrub. Flowers in stalked cymes. Calyx scarlet, tinged with orange, much enlarged in fruit, tube very short, 1" in diameter.

Flowers: October—December.

***Duranta plumieri**, *Jacq. Duthie. Fl. II*, p. 229.

An erect shrub with spinose branches. Leaves oblong lanceolate, acuminate. Flowers blue in terminal racemes. Berries orange coloured.

***Petrea volubilis**, *Linn. Duthie, Fl. II*, p. 229.

A large woody climber with very scabrous ovate leaves. Calyx large persistent, blue. Corolla violet, caducous.

LXXII. LABIATAE

Ocimum, *Linn.*

Strongly scented herbs. Leaves opposite. Flowers small in whorls, pedicels with recurved tips. Calyx 2-lipped, ovoid, persistent. Corolla 2-lipped, upper-lip 4-fid, lower entire. Stamens 4, didynamous, exserted. Ovary 4-partite. Fruit a carcerullus.

Ocimum sanctum, *Linn. Fl. Brit. Ind. IV*, p. 609. Vern. *Tulsi*.

A much branched herb. Leaves 1-2" long, entire, hairy. Calyx elongating in fruit. Corolla purplish-pink, $\frac{1}{2}$ " long.

Flowers: December—February.

Ocimum basilicum, *Linn. Fl. Brit. Ind. IV*, p. 608. Vern. *Ban tulsi*.

An erect branching herb, 2-3 ft. high. Corolla white, pink or purplish.

Flowers: December—February.

Ocimum canum, *Sims. Fl. Brit. Ind. IV*, p. 607.

Similar to the preceding one excepting that corolla is smaller.

Anisomeles ovata, *R. Br. Fl. Brit. Ind. IV*, p. 672.

A much branched herb, tomentose. Leaves $1\frac{1}{2}$ —3" long, ovate, acute, crenate-serrate, pubescent. Flowers in axillary whorls, purplish. Calyx enlarged in fruit. Corolla 2-lipped, lower-lip deep blue, much longer. Stamens didynamous, anthers of the upper pair 2-celled, those of the lower 1-celled. Ovary 4-partite. Fruit of 4 mericarps.

Flowers during the rainy season.

Leucas, *R. Br.*

Herbs, usually hairy. Leaves opposite. Flowers in verticillasters. Calyx 6—10 toothed, tubular, mouth straight or oblique. Corolla 2-lipped, white, upper-lip erect, lower-lip spreading, 3-fid. Stamens didynamous. Ovary 4-partite. Fruit of 4 mericarps.

Leucas aspera, *Spreng. Fl. Brit. Ind. IV*, p. 690. Vern. *Gooma*.

An erect annual, 6—18" high, branches 4-angled. Leaves linear, crenate, base tapering. Mouth of the calyx glabrous. Upper lip of corolla woolly.

Flowers: December—April.

Leucas cephalotes, *Spreng. Fl. Brit. Ind. IV*, p. 689.

A pubescent annual, very similar to the last one excepting that the mouth of the calyx is hairy within.

Leonotis nepetaefolia, *R. Br. Fl. Brit. Ind. IV*, p. 691. Vern. *Bara gooma*.

Herbs. Flowers large arranged in verticillasters. Calyx 10-nerved, persistent, mouth oblique, 8—10 teeth, spine-tipped, upper toothed, largest. Corolla 2-lipped, upper long, orange-scarlet.

Flowers: October—December.

Nepeta ruderalis, *Buch-Ham. Fl. Brit. Ind. IV*, p. 661.

A densely pubescent annual, branches erect, 4-angled. Leaves ovate crenate. Flowers pedicellate, unilaterally arranged in dense many flowered cymes. Corolla exserted, bluish-purple. Stamens didynamous, upper pair larger.

Flowers: December—March.

***Salvia officinalis**.

It is a common garden sage, grown in cold season, with scarlet flowers.

***Coleus amboinicus**, *Lour. Fl. Brit. Ind. IV*, p. 625.

Vern. *Pathor chur*.

A fragrant perennial herb. Stem fleshy. Leaves stalked, ovate, cordate, crenate, hairy. Corolla pale-purple.

***Mentha piperata**, *Linn. Fl. Brit. Ind. IV*, p. 647. Vern.

Pudina.

A prostrate herbaceous plant with suckers. Leaves with peculiar smell. Flowers white, actinomorphic.

LXXIII. NYCTAGINACEAE

Boerhaavia, *Linn.*

Diffuse herbs. Leaves opposite, often unequally paired. Flowers small, arranged in panicles, umbels, pedicels jointed. Perianth one whorl, petaloid, tube long or short, ovoid below, limb funnel-shaped, 5-lobed. Stamens 1—5, exserted, hypogynous. Ovary 1-celled, ovule solitary, basal, erect. Fruit small 5-ribbed achene.

Boerhaavia diffusa, *Linn. Fl. Brit. Ind. IV*, p. 709.

A diffusely branched herb. Stems 2-3 ft. long, prostrate, swollen at the nodes, hairy, often tinged with purple. Leaves thick, in unequal pairs, $\frac{1}{2}$ — $1\frac{1}{2}$ " long,

ovate, usually white beneath, margins often pink. Flowers minute, 4—10 together. Perianth $1\frac{1}{8}$ " long. Stamens 2 or 3. Fruit $1\frac{1}{8}$ " long.

An abundant weed within the area and very variable in habit according to the soil and environment.

Flowers throughout the year.

Boerhaavia repanda, Willd. *Fl. Brit. Ind. IV*, p. 709.

A diffuse sub-scandent herb, branches 3—6 ft. long. Leaves in nearly equal pairs. 1—3" long, triangular, ovate. Flowers 3—8 together, on long slender pedicels. Pedicels $\frac{1}{4}$ —1" long. Perianth pink, $\frac{3}{4}$ " long.

Flowers: August—April.

***Bougainvillea spectabilis**, Willd. *Duthie. Fl. III*, p. 4.

A robust thorny extensively climbing shrub. The flowers are in cymes surrounded by as many petaloid bracts, brilliant pink.

***Bougainvillea lateritia**. (A garden variety.)

Similar as above with crimson red bracts.

***Bougainvillea glabra**, Choisy.

It is less robust as climber and almost devoid of thorns.

***Mirabilis jalapa**, Linn. *Duthie. F. III*, p. 3.

A tall much branched perennial herb, bearing a profusion of yellow white, crimson or variegated flowers.

LXXIV. AMARANTACEAE

Celosia argentea, Linn. *Fl. Brit. Ind. IV*, p. 714. Vern.

Safed murgh ka phul.

An erect annual, 1—3 ft. high. Leaves alternate, petiolate, simple, 1—4" long, lanceolate. Flowers bisexual in terminal spikes, white or pink. Perianth seg-

ments 5, connate below, erect in fruit. Stamens 5, anthers 2-celled. Ovary 1-celled, 2 or more ovules. Fruit a capsule, seeds 4—8.

Flowers during the cold season.

**Celosia cristata*, Linn. *Fl. Brit. Ind. IV*, p. 715. Vern. *murgh ka phul*. (Cockscomb).

Closely allied to the preceding one but with taller and broader leaves. Flowers pink or yellow borne on the fasciated crest-like divisions of the spikes.

Flowers during the rainy season.

Digera arvensis, Forsk. *Fl. Brit. Ind. IV*, p. 717.

A slender annual weed, erect. Leaves alternate, entire, petiolate, $\frac{1}{2}$ —3" long. Flowers in spikes, 1—5" long, ternate, the 2 outer reduced to crested scales, the central one perfect. Perianth, calycine, segments 5, slightly connate below, oblong, erect, the outer longer, pink. Stamens 5, hypogynous, anthers 2-celled. Ovary 2-celled, stigmas 2, 1 ovule erect. Fruit a globose achene.

Flowers usually after the rains.

Amarantus, Linn.

Erect annual herbs. Leaves alternate. Flowers small, unisexual, on the same plant, in axillary clusters or dense terminal spikes. Bracts herbaceous, persistent. Perianth 3—5, ovate-lanceolate segments, erect in fruit. Stamens 5, free, anthers 2-celled, staminodes one. Ovary ovoid, compressed, stigmas 2 or 3, ovule solitary, erect.

Amarantus spinosus, Linn. *Fl. Brit. Ind. IV*, p. 718.

An erect spinous herb. Branches grooved, spines in the leaf axils. Leaves $1\frac{1}{4}$ —4" long, ovate, spine-tipped, long petioled. Flowers many. Perianth 5. Stamens 5.

Flowers during the rains.

Amarantus gangeticus, *Linn. Fl. Brit. Ind. IV*, p. 719.
Vern. *Chaulai*.

An erect annual. Stems 2—4 ft. high, tinged with purple, unarmed. Leaves very variable, petioles up to 3" long. Perianth 3. Stamens 3.

Nothosaerua brachiata, *Wight. Fl. Brit. Ind. IV*, p. 726.

An erect slender herb with opposite spreading branches. Leaves opposite, thinly membranous, $\frac{1}{4}$ — $1\frac{1}{2}$ " long, elliptic-lanceolate. Flowers minute bisexual, woolly. Perianth 3—5, hyaline, villous. Stamens 2, free, anthers 2-celled, staminodes none. Ovary oblong, solitary pendulous ovule.

Achyranthes aspera, *Linn. Fl. Brit. Ind. IV*, p. 730.
Vern. *Latzira*.

A coarse weed 1—3 ft. high. Leaves opposite, entire, petiolate up to 5" long, elliptic-ovate, tomentose, usually white velvety on the lower surface. Flowers bisexual, many on terminal spikes which elongate in fruit up to 20" long. Bracts and bracteoles spinescent. Perianth 4—6, acuminate. Stamens 5. Ovary oblong, ovate, solitary, pendulous ovule.

Flowers: September—November.

Pupalia lappacea, *Juss. Fl. Brit. Ind. IV*, p. 724.

A large straggling herb, tomentose. Leaves opposite, petiolate, $1\frac{1}{2}$ —4" long, acute, ciliate. Flowers fascicled on simple or paniced spikes, fascicles containing one perfect flower and several imperfect ones. Perianth segments of perfect flowers 5, slightly connate below, 3—5 nerved. Perianth segments of imperfect flowers are reduced to stellately spreading hooked bristles. Staminodes none. Ovary ovoid, ovule solitary.

Flowers towards the end of the rainy season.

Alternanthera sessilis, *R. Br. Fl. Brit. Ind. IV*, p. 731.

A prostrate herb, often rooting at nodes. Leaves opposite, $\frac{1}{2}$ —2" long, linear, oblong. Flowers bisexual, white, clustered. Perianth segments 5, unequal, ovate, 1-nerved, anterior and 2 posterior flattened, the 2, lateral innermost concave. Stamens 2—5, anthers 1-celled. Ovary ovoid, stigma 2-fid, ovule solitary.

Aerua tomentosa, *Forsk. Fl. Brit. Ind. IV*, p. 727.

A hoary tomentose herb, 2-3 ft. high. Leaves alternate, sessile. Flowers minute, bisexual. Stamens 5 or 4, with intervening staminodes. Ovule solitary pendulous.

Flowers throughout the year.

***Gomphrena globosa**, *Linn. Fl. Brit. Ind. IV*, p. 732.

A tall much branched annual. Leaves pale-green, 2—4" long, elliptic, heads large, globose, pink-white, bracts leafy. Perianth dense woolly. Anthers 1-celled.

Flowers during the rainy season and cold season.

LXXV. CHENOPODIACEAE

Chenopodium album, *Linn. Fl. Brit. Ind. V*, p. 3. Vern. *Bathua*.

An erect annual, coated with white mealy pubescence. Stems angled, often tinged with red or purple. Leaves alternate, entire, lobed. Flowers minute, bisexual, in axillary clusters, forming a paniced spikes. Bracts and bracteoles none. Perianth 5-lobed, segments concave. Stamens 5 or fewer, hypogynous, anthers 2-celled. Ovary globose, stigmas 2—5, 1-celled, solitary basal ovule.

Flowers during the cold season.

***Basella rubra**, *Linn. Fl. Brit. Ind. V*, p. 20. Vern. *Poi*.

A glabrous fleshy, much branched climbing herb, often tinged with red. Leaves alternate, broad, entire,

2—5" long, ovate, acute. Flowers in spikes, 2-sexual, white or red, sessile, bracts minute, bracteoles 2, longer than the perianth. Perianth 5-fid fleshy, lobes short, incurved. Stamens 5, filaments short. Styles 3, stigmas 2, ovule one. Fruit globose, red or black.

Flowers during the cold season.

***Beta vulgaris**, *Linn. Fl. Brit. Ind.* Vern. *Chukandar*.
(Garden beet).

Extensively grown in India for its roots which are used as salad.

***Spinacia oleracea**, *Linn. Fl. Brit. Ind. V*, p. 6. Vern. *Palak*.

Largely grown in the gardens. Flowers unisexual, the males being crowded in terminal leafless spike, and the females arranged in axillary clusters.

LXXVI. POLYGONACEAE

Polygonum, *Linn.*

Herbs, leaves alternate, entire, stipules ochreate. Flowers bisexual, small, minute, clustered in racemes. Perianth green or coloured, 4—5 cleft, the outer lobes smallest. Stamens 6—8, filaments dilated at the base. Ovary free, sessile, compressed, 1-celled, style 2 or 3, solitary ovule. Fruit compressed, 3-gonous nutlet.

Polygonum plebium, *R. Br. Prod. Fl. Brit. Ind. V*, p. 27.

A prostrate diffusely branched herb with woolly rootstock. Leaves sessile, stipules hyaline. Flowers axillary, solitary, sessile. Perianth pink, segments short. Fruit 3-gonous.

Polygonum glabrum, *Willd. Fl. Brit. Ind. V*, p. 34.

An erect glabrous annual, 2—5 ft. high. Stems stout, usually tinged with red. Leaves 3—9" long, lan-

ceolate, acuminate, tapering at the base, stipules 1—1½" long, ochreate. Racemes erect slender, 2—4" long. Perianth ¼" long, pink or white. Stamens 6—8. Styles 2, rarely 3, connate below. Fruit 3-angled.

Abundant near streams and swamps.

Rumex dentatus, *Linn. Fl. Brit. Ind. V*, p. 59.

An erect annual, 1-2 ft. high. Stems grooved tinged with red. Leaves 3-4" long, oblong, obtuse, base rounded. Flowers shortly pedicelled, bisexual. Perianth segments ovate, much enlarged in fruit with an ovoid smooth tubercle on the back. Nutlets 3-gonous or winged.

Flowers: February-March.

***Antigonum leptopus**, *Hook. and Arn. Duthie. Fl. II*, p. 43. (The Coral Creeper.)

A large handsome climbing shrub with bright pink flowers.

***Muehlenbeckia platycladus**, *Meisn. (Cocoloba platyclada, F. Muell). Duthie. Fl. II*, p. 43.

A quaint looking shrub with flattened leaf-like (cladodes) branches, is grown in the garden.

LXXVII. ARISTOLOCHIACEAE

***Aristolochia saccata**, *Wall. Fl. Brit. Ind. V*, p. 76.

A perennial climbing plant. Leaves with petioles dilated at the base and often with a stipule-like leaf of an undeveloped bud in the axil. Perianth coloured, tube inflated below, then contracted, hairy within, limb dilated oblique, usually 2-lipped. Stamens 6, adnate in one series above the ovary, anthers adnate to the column. Ovary 4—6 celled, parietal placentas, extending to the axis. Fruit a capsule, lantern-like, 5-valved.

Flowers: October-November.

LXXVIII. PIPERACEAE

**Peperomia pellucida*, *H. B. & K. Duthie. Fl. III*, p 47.

A slender much branched glabrous and succulent annual. Leaves usually entire, alternate, ovate. Flowers minute, unisexual on the same plant, in axillary or terminal spikes, bracts and braceoles. Perianth absent. Stamens 2—6, hypogynous. Ovary 1-celled, solitary erect ovule. Fruit a small ovoid berry.

Flowers during the rainy season.

**Peperomia betel*, *Linn. Fl. Brit. Ind. V*, p. 85. Vern. *Pan.*

A perennial dioecious creeper. The leaves are succulent. A shade-loving plant.

LXXIX. PROTEACEAE

Grevillea robusta, *A. Cunn. Haines—Botany*, p. 800.

A tree with graceful spreading and lobed leaves. Inflorescence a raceme with 2 flowers in each axil. The flowers are hermaphrodite, zygomorphic. Perianth 4, gamo, corolline, valvate, the lobes commonly bent or rolled back when open. Stamens 4, inserted on the perianth with only the anthers free. Monocarpellary with amny ovules, style terminal, long, bent inwards. The style projects from the bud as a long loop, the stigma being help up by the perianth until the pollen is shed upon it. Then the style straightens out, and the pollen is removed. Fruit is a follicle.

Flowers: March-April.

LXXX. LORANTHACEAE

Loranthus longiflorus, *Desr. Fl. Brit. Ind. V*, p. 214. Vern. *Banda*.

A large bushy branched parasite (partial). Leaves usually opposite, entire, thickly, coriaceous, 3—7" long.

Flowers 2-sexual in racemes, pedicels short. Calyx cupular, 5-toothed, adnate to the ovary. Corolla gamo, 4—6 lobes, tubular, orange-coloured. Stamens 4—6, adnate to the petals, anthers versatile. Ovary inferior, 1-celled, style short, stigma simple, ovule solitary, erect. Fruit 1-seeded berry.

Commonly found on *mango*, *mahua*, *nim* plants.
Flowers during the winter season.

LXXXI. SANTALACEAE

**Santalum album*, *Linn. Fl. Brit. Ind. V*, p. 231. Vern.
Chandan.

A small glabrous evergreen tree with drooping branches. A partial root-parasite. The yellowish-brown strongly-scented heartwood is the well-known sandalwood of commerce.

Flowers: August—January.

LXXXII. EUPHORBIACEAE

Euphorbia, *Linn*.

Herbs or shrubs with copious milky juice. Stems slender and leafy or thick and fleshy or sometimes leafless. Leaves alternate or opposite, entire. Flowers unisexual, occurring on the same plant, combined in an inflorescence called cyathium. There is a cup-shaped involucre, the margin of which bears a number of crescent-shaped glandular scales. Inside the cup there are a number of stamens, also an ovary borne on a stalk. The whole structure looks like a single flower, but each stamen is really a male flower, and the gynaecium with its stalk is a female flower. This is borne out by the fact that each stamen is articulated to a stalk and has a scaly bract at its base. Each stamen has 2-celled anthers. Ovary 3-celled, styles 3, one ovule in each cell. Fruit a capsule.

Euphorbia neriifolia, *Linn. Fl. Brit. Ind. V*, p. 255. Vern.
Thor, Senhur.

A large erect glabrous shrub up to 20 ft. high. Branches fleshy, cylindric. Leaves alternate, fleshy, clustered towards the end, 4—8" long, obovate.

Flowers during the summer season.

Euphorbia dracunculoides, *Lamk. Fl. Brit. Ind. V*, p. 262.

A glabrous dichotomously branched annual. Stems many, erect, leafy, 12—18" high. Leaves $1\frac{1}{4}$ — $2\frac{3}{4}$ " long, linear.

Flowers: March—June.

Euphorbia thymifolia, *Linn. Fl. Brit. Ind. V*, p. 252.

A small annual herb, more or less pubescent, whole plant often with coppery tinge. Stems prostrate, slender. Leaves very small, opposite petiolate, $1/8$ — $1/4$ " long, oblong, obtuse, crenate.

Flowers during the greater part of the year.

Euphorbia rothiana, *Spreng. Fl. Brit. Ind. V*, p. 263.

An erect glaucous annual herb. Stem 1-2 ft., glabrous, terete, much branched above, often tinged with red. Leaves alternate, 2— $4\frac{1}{2}$ " long, linear, lanceolate, acute, entire, tapering to the base.

Euphorbia hypericifolia, *Linn. Fl. Brit. Ind. V*, p. 249.

An erect decumbent annual. Leaves opposite, $\frac{1}{4}$ — $1\frac{1}{2}$ " long, very variable in shape.

Flowering all through the year.

***Euphorbia pulcherrima**, *Willd. Duthie. III*, p. 83.

The well-known *Poinsettia* with very handsome crimson upper floral leaves.

***Euphorbia splendens**, *Boj. Duthie. Fl. III*, p. 83.

A small prickly much branched shrub with crimson flowers.

***Euphorbia tirucalli**, *Linn. Fl. Brit. Ind. V*, p. 254.
Vern. *Sehnd.*

A shrub with very smooth spreading terete and rush-like almost leafless branches.

Phyllanthus, *Linn.*

Herbs, shrubs, or trees. Leaves distichous, entire. Flowers small, unisexual. Males many, fascicled, pedicellate, females in the same or on different axils with longer pedicels, solitary or few. Perianth simple. Male flowers: sepals 4—6, free, imbricate, 2-seriate, disc glandular, stamens 3, rarely 4 or 5, filaments free or connate, anthers 2-celled, pistillode none. Female flowers: sepals as in male, 1-seriate, disc glandular, ovary usually 3-celled, style free or connate, 2-fid, ovules 2 in each cell. Fruit of 3 coriaceous bony 2-valved cocci, sometimes a 4-celled berry.

Phyllanthus reticulatus, *Poir. Fl. Brit. Ind. V*, p. 288.

A large scandent shrub, branchlets slender, drooping, smooth. Leaves variable, thin, pale beneath, 1-2" long, oblong, elliptic, obtuse or acute at the apex, base rounded, main lateral nerves 6—8 pairs, slender. Flowers axillary, males in fascicles, females solitary. Stamens 5, ovary 5—10 celled, ovules 2 in each cell, styles 3. Fruit a globose berry, dark-purple when ripe.

Phyllanthus emblica, *Linn. Fl. Brit. Ind. V*, p. 289.
Vern. *Aonla*.

A moderate sized tree, bark light-grey, peeling off in small regular patches, red inside. Branches spreading, often deciduous. Leaves small, sessile, distichously arranged, $3/8$ — $1\frac{1}{2}$ ", narrowly linear, obtuse pale-green. Flowers greenish-yellow, arranged in axillary fascicles on the leaf-bearing branches. Male flowers: many, shortly pedicelled, sepals 6, anthers 3, erect. Female

flowers: few, sessile, sepals 6, disc cupular, ovary 3-celled. Fruit fleshy, globose, pale-yellow.

Flowers: March—May.

Phyllanthus maderaspatensis, *Linn. Fl. Brit. Ind. V*, p. 292.

A glabrous annual. Stems erect, 1—3 ft., decumbent below. Leaves scattered $\frac{1}{4}$ — $1\frac{1}{4}$ " long, cuneate, ovate. Flowers axillary. Males minute in small clusters. Females solitary and longer. Sepals 6, obovate. Stamens 3. Styles 3, minute, free, 2-lobed. Fruit a small capsule.

Flowers during the rains.

Phyllanthus urinaria, *Linn. Fl. Brit. Ind. V*, p. 293.

An annual. Stems erect, often tinged with red. Leaves sessile, $\frac{1}{4}$ — $\frac{1}{2}$ " long, oblong. Flowers minute, solitary. Sepals green. Capsule $1/8$ " in diameter.

Flowers during the rains.

Phyllanthus niruri, *Linn. Fl. Brit. Ind. V*, p. 298.

A glabrous annual, up to 2 ft. high. Leaves $\frac{1}{4}$ — $\frac{3}{8}$ " long. Flowers axillary, numerous, very minute. Stamens 3, anthers didymous, on a short column. Styles minute, free, 2-lobed. Capsule depressed, globose.

Flowers: July-August.

Phyllanthus simplex, *Retz. Fl. Brit. Ind. V*, p. 295.

A glabrous herb. Leaves many, distichous. Flowers usually, solitary. Stamens 3, filaments free, anthers didymous. Capsule globose.

Phyllanthus distichus (Cicca disticha), *Muel-Arg. Fl. Brit. Ind. V*, p. 304. Vern. *Harfarewri*.

A deciduous tree. Leaves pinnately distichous. Flowers minute, clustered, unisexual on the same plant.

Sepals 4, in both sexes. Stamens 4, filaments free. Ovary tricarpeal, styles 4, free. Fruit fleshy, 3-4 celled, bony endocarp.

Flowers: April-May.

***Phyllanthus speciosus**, *Jacq. Engler. XIX*, p. 65.

A herbaceous plant with cladodes bearing flowers.

Putranjiva roxburghii, *Wall. Fl. Brit. Ind. V*, p. 336.

A moderate sized evergreen tree. Branches drooping. Leaves alternate coriaceous, dark-green shining, $2\frac{1}{2}$ —4" long, obliquely elliptic-oblong obtuse, entire. Flowers small, yellow, unisexual, both on the same or separate plants. Male flowers: arranged in dense spikes, sepals, 3—5, oblong obtuse, stamens 3, anthers globose. Female flowers, 2-3.

Flowers: April-May.

Chrozophora rottleri, *Juss. Fl. Brit. Ind. V*, p. 409.

An erect hairy annual up to 2 ft. high. Stem usually naked below. Leaves alternate, ovate, often 3-lobed, thick, rugose, stellately hairy, petioles 1-2" long. Flowers unisexual, on the same plant, in sessile axillary racemes. Males crowded in the upper part, female solitary and pedicelled. Male flowers: calyx globose, splitting into 5 segments, petals 5, smaller, stamens 15 in two whorls. Female flowers: sepals 5, petals 5, shorter, disc of short glands, ovary 3-celled, styles 2-fid, ovules solitary in each cell. Fruit a capsule, 2-valved, $\frac{1}{3}$ " in diameter.

Flowers: January—April.

Acalypha, *Linn.*

Herbs, leaves alternate, toothed, 3—5 nerved. Flowers small, unisexual, apetalous, arranged in axillary or terminal racemes. Male flowers minute, without bracts, female flowers 1-2, within a peduncled solitary bract or sometimes at the base of a large accrescent leafy

bracts. Male flowers: sepals 4, valvate, stamens 8, filaments short, free. Female flowers: sepals 3-4, minute, imbricate, ovary 3-celled, style filiform, often long and lacinate or fimbriate, ovules solitary in each cell. Fruit a capsule.

Acalypha indica, *Linn. Fl. Brit. Ind. V*, p. 416.

An erect annual herb, 1—1½ ft. high. Leaves thin, glabrous, 1—3" long, ovate, crenate-serrate. Flowers in lax erect axillary elongate spikes. Males minute, clustered towards the apex of the spike, ebracteate. Females in clusters of 3—5, subtended by a shortly stalked leaflike bract. Capsule hispid, 1-seeded.

Flowers during the greater part of the year.

Acalypha ciliata, *Forsk. Fl. Brit. Ind. V*, p. 417.

A stout herb, 1—2½ ft. high. Stems erect, pubescent when young. Leaves thin, 1¾—3" long, ovate, acuminate, serrate. Flowers in axillary spikes. Males few, very minute and sessile at the top. Females many crowded, at the base, bracts large, pale-green, 1—2 flowered. Capsule glabrous.

Flowers during the rainy season.

Ricinus communis, *Linn. Fl. Brit. Ind. V*, p. 457. Vern.

Arand. (The castor-oil plant).

A tall annual. Leaves alternate, broad, palmately lobed, lobes 7 or more, serrate. Flowers unisexual, both on the same plant, large in terminal racemes. Perianth simple. The male flowers crowded in the upper portion of the inflorescence, the females below. Male flowers: calyx membranous, splitting into 3-segments, stamens very many, filaments connate and branched, anthers with divergent cells. Female flowers: calyx spathaceous, caducous, ovary 3-celled, styles entire, stigma 2-fid, ovules solitary in each cell. Fruit a regma.

Flowers: December—February.

Baliospermum axillare, *Blume. Fl. Brit. Ind. V*, p. 461.

A stout leafy undershrub, 3—6 ft. high. Leaves alternate, coriaceous, upper 2-3" long, lanceolate, lower 6—12" long, 3—5 lobed, stipules of 2 glands. Flowers small, unisexual or bisexual, apetalous. Male flowers: globose, sepals 4—6, disc of 4 glands, stamens 10—30, free. Female flowers: sepals 5-6, disc entire, ovary 3-celled, ovule 1 in each cell.

Flowers: October—December.

***Jatropha gossypifolia**, *Linn. Duthie. Fl. III*, p. 116.

A soft wooded evergreen shrub. Young parts bronzed. Leaves 2—5 partite, obovate-lanceolate, closely toothed and glandular, ciliate, upper surface with white dots, petiole 2—4½", covered with glands.

Flowers during the rainy season.

LXXXIII. URTICACEAE

Haloptelea integrifolia, *Planch. Fl. Brit. Ind. V*, p. 481.

Vern. *Chilwil*.

A large deciduous spreading tree. Bark grey. Leaves alternate, distichous, entire, coriaceous, 3—5" long, elliptic, acuminate, shining. Flowers polygamous or bisexual, the males without a rudimentary ovary, arranged in fascicles at the scars of the previous years' shoot which are leafless. Perianth simple, calycine, 4—8 partite, imbricate, unequal. Stamens 4—8, erect anthers hairy. Ovary compressed, style short bifid, ovule solitary, pendulous. Fruit samara.

Flowers: March-April.

Cannabis sativa, *Linn. Fl. Brit. Ind. V*, p. 487. Vern.

Bhang (The hemp.)

A tall annual. Leaves alternate, lower opposite, 1—3" long, 5—10 partite, lobes lanceolate, serrate, stipulate.

Flowers small unisexual, on separate plants, rarely on the same. Males in axillary paniculate cymes, females in axillary racemes, bracteate. Male flowers: sepals 5, imbricate, stamens 5, erect in bud. Female flowers: perianth, hyaline, embracing the ovary, ovary sessile, bicarpellary, of which only one is fertile, unilocular, ovule pendulous. Fruit a nut.

Flowers: January—March.

Morus alba, *Linn. Fl. Brit. Ind. V*, p. 492. Vern. *Shahtut*. (The mulberry).

A medium sized tree with milky juice. Leaves alternate, entire, toothed, 2-3" long, 3-lobed, dentate, stipulate, stipules caducous. Flowers minute, unisexual, on the same plant. Male flowers in elongate catkin-like spike, sepals 4, imbricate, stamens 4, inflexed in bud. Female flowers: sepals 4, decussate imbricate, accrescent, ovary included, 1-celled, ovule pendulous. Fruit a sorosis.

Flowers: February—April.

***Morus nigra**, *Linn. Brandis*.

A cultivated species.

Artocarpus, *Forst.*

Evergreen trees with milky juice. Leaves alternate, coriaceous, often very large, entire or pinnately lobed, stipules lateral. Flowers unisexual, densely crowded on globose solitary axillary receptacles, often mixed with scale-like peltate bracts. Male flowers: perianth 2-4 lobed or partite, lobes obtuse, valvate, stamen 1, erect. Female flowers: perianth tubular, confluent below with the receptacle, limb minute, very straight, stigma entire, ovule pendulous. Fruit a much enlarged fleshy oblong,

cylindrical, globose receptacle, clothed, bearing on its upper surface the accrescent fleshy perianths and carpels (anthocarps) which have hard spinous apices-Achenes deeply sunk in the fleshy mass.

Artocarpus lakoocha, *Roxb. Fl. Brit. Ind. V*, p. 543.
Vern. *Barhal*.

A large deciduous tree, 50 ft. high. Leaves 4—12" long, oblong, entire, dark green, main lateral nerves 6—12 pairs. Flowers in axillary globose heads, male and female heads from different axils. Male flowers: sepals 2-3 truncate, stamen 1, 2-celled. Female flowers: perianth tubular, ovary straight, ovule pendulous. Fruit a sorosis, in clusters, 2-3" long, sunken, velvety, yellowish when ripe. Fruitlets surrounded by fleshy perianths immersed in the fleshy receptacle.

Flowers: March—May.

Artocarpus integrifolia, *Linn. Duthie. Fl. III*, p. 142.
Vern. *Kathal*.

A large evergreen tree with leaves 4—8" long, thickly coriaceous. Fruit 1-1½ ft. long.

Flowers: March—April.

Ficus, *Linn.*

Trees or shrubs, sometimes scandent or epiphytic, with milky juice. Leaves alternate, rarely opposite, entire, lobed, toothed or serrate, stipulate, enveloping the bud, caducous. Flowers minute, usually unisexual on the same plant, on the inner walls of a fleshy receptacle, the mouth of which is closed by imbricate bracts, florets often mixed with bracteoles, of four forms, male, female, gall and neuter, receptacle androgynous, the males nearest the mouth; male, female and gall flowers sometimes occur in the same receptacle or the male and galls may be

in one set, females only in another. Male flowers: perianth 2—6 fid or partite, stamens 1 or 2, rarely 3—6, erect in bud. Neuter; perianth as in males. Female flowers: perianth as in males or imperfect or obsolete, ovary straight or oblique, style excentric, stigmas entire, or 2-armed, ovule pendulous. Gall flowers: perianth as in females, ovary containing the pupa of a hymenopterous insect, style short, often dilated upwards. Fruit—syconous—an enlarged hollow cup-shaped closed receptacle.

Ficus bengalensis, *Linn. Fl. Brit. Ind. V*, p. 499. Vern. *Bergad. Bar.*

A large nearly evergreen tree up to 100 ft. high, branches horizontally spreading and throwing down at intervals a succession of aerial roots which form the support for the indefinite elongation of the main branches by which the growth of the tree is extended. Receptacle about 1" in diameter.

Ficus religiosa, *Linn. Fl. Brit. Ind. V*, p. 513. Vern. *Peepal.*

A large glabrous tree usually at first epiphytic. Leaves coriaceous, shining, with long petioles, drooping, 4—7" long, ovate, round, entire, dip-trip. Receptacle $\frac{1}{2}$ " in diameter.

Flowers: April-May.

Ficus infectoria, *Roxb. Fl. Brit. Ind. V*, p. 515. Vern. *Pakar.*

A large spreading deciduous fast growing tree, often epiphytic in early life and sometimes sending down a few aerial roots from the trunks or branches. Leaves membranous, $3\frac{1}{2}$ "—5" long, ovate, acuminate, entire, 3-nerved, main lateral nerves 3—7 pairs. Receptacles axillary, in pairs, sessile, globose, $\frac{1}{4}$ " in diameter, whitish, flushed with red and dotted when ripe.

Ficus glomerata, *Roxb. Fl. Brit. Ind. V*, p. 535. Vern. *Gular*.

A tree up to 60 ft. high, bark smooth, reddish brown. Leaves membranous, 4—7" long, ovate oblong, entire, 3-nerved, main lateral nerves 4—6 pairs. Receptacles in clusters, on the main trunk and larger branches, (cauliflory), subglobose, pyriform, smooth, 1—2" across, reddish-orange coloured when ripe, base much contracted, with 3 triangular bracts.

Figs ripen between April and July.

***Ficus elastica**, *Roxb. Fl. Brit. Ind. V*, p. 508. (India-rubber tree).

The well-known india-rubber tree, a native of the eastern Himalayas up to 3,000 ft., also in Assam and Khasia hills.

***Ficus carica**, *Linn. Brandis*, p. 607. Vern. *Anjir*.

***Pilea mucosa**, *Lindl. Duthie. Fl. II*, p. 126.

A very small tufted glabrous herb. Stems succulent, flaccid. Leaves small, orbicular, ovate, rounded at the apex, entire. Flowers minute, unisexual, on the same plant. Male flowers: sepals 2—4, free, stamens 2—4. Female flowers: sepals 3, ovary straight, stigma sessile, ovule erect.

Flowers throughout the year.

LXXXIV. CASUARINACEAE

Casuarina equisetifolia, *Forst. Fl. Brit. Ind. V*, p. 598.

A tall handsome straight-stemmed leafless tree. Branches terminating in long slender drooping deciduous, 6—8 jointed branchlets, which perform the functions of leaves. The ribs of each joint terminates upwards in the teeth or scales of a membranous sheath, alternating with ribs of the next joint above. Male flowers naked monan-

drous, in terminal cylindric spikes and the females are naked arranged in small cone like clusters which become woody when ripe.

Flowers throughout the year.

LXXXV. CERATOPHYLLACEAE

Ceratophyllum demersum, *Linn. Fl. Brit. Ind. V*, p. 639.

Slender fragile, branched, submerged aquatic herb. Leaves whorled dichotomously cleft into filiform, minutely toothed lobes, exstipulate. Flowers minute, unisexual, axillary, sessile. Male flowers: solitary, perianth of 6—12 narrow, 2-fid segments, stamens 10—20, filaments very short, anthers erect. Female-flowers: perianth as in male flowers, ovary sessile, ovoid, 1-celled, ovule solitary, pendulous. Fruit a nutlet.

MONOCOTYLEDONES

I. HYDROCHARITACEAE

Hydrilla verticillata, *Royle. Fl. Brit. Ind. V*, p. 659.

A submerged leafy fresh-water herb, often rooting at the nodes. Leaves short, usually opposite, whorled above, 4—8", sessile, $\frac{1}{2}$ — $\frac{3}{8}$ " long, entire, linear. Flowers minute unisexual, on different plants, the males shortly pedicelled, solitary on a subglobose spathe. Females sessile, 1-2 in a tubular, 2-toothed spathe. Male flowers: sepals 3, ovate, petals 3, oblong, stamens 3, anthers large, reniform. Female flowers: sepals 3, linear, green, petals 3, narrow, ovary produced beyond the spathe in a filiform beak, 1-celled, 3—6 parietal placentas, styles 2-3, linear, stigmas fimbriate. Fruit ovoid, dehisces irregularly.

Flowers: December—March.

Vallisneria spiralis, *Linn. Fl. Brit. Ind. V*, p. 660.

Submerged tufted stemless, stoloniferous herb. Leaves radical, very long, linear, translucent, entire. Flowers unisexual on different plants, the males numerous, minute in an ovoid 3-lobed shortly peduncled spathe, the females solitary, in a tubular 3-toothed spathe, terminal on a very long spiral scape. Sepals 3. Petals 3, minute or none. Male flowers: stamens 1—3, filament rather thick, anthers didymous. Female flowers: staminodes 3, each 2-fid, ovary narrow, stigmas 3 broad, notched, ovules numerous on parietal placentas. Fruit a linear capsule.

Flowers: December—March.

Ottelia alismoides, *Pers. Fl. Brit. Ind. V*, p. 662.

Submerged or partially floating fresh-water herb with fibrous roots. Leaves radical, crowded, the submerged narrow and shortly petiolate, the floating long petioled, ovate-lanceolate, oblong-cordate. Flowers solitary, bisexual, sessile, within a tubular long peduncled spathe. Sepals 3, linear, oblong. Petals 3, larger than the sepals, obvate. Stamens 6—15, in 2—5 series, anthers erect. Ovary oblong, beaked, 6-celled, styles 6, linear, 2-fid, ovules many on parietal placentas. Fruit 2-valved capsule.

Flowers: November—February.

II. SCITAMINEAE

The following plants of this family are commonly cultivated in the fields and gardens:—

***Curcuma longa**, *Linn. Fl. Brit. Ind. IV*, p. 214. Vern. *Haldi*. (Turmeric).

A tall herb. Rootstock large, ovoid, with sessile cylindric tuberous, orange coloured inside. Leaves very large, in tufts, up to 4" or more long, including the

petiole which is about as long as the blade, oblong-lanceolate, tapering to the base. Flowers in autumnal spikes, 4—6" long, peduncles 6", concealed by sheathing petiole. Flowering bracts pale-green, tinged with pink.

***Zingibar officinale**, *Rosc. Fl. Brit. Ind. VI*, p. 246. Vern. *Adrakh*. Ginger.

A herb with horizontal jointed tuberous rhizomes. Stem slender, 3-4 ft. high. Leaves 6—12", long lanceolate glabrous beneath. Bracts orbicular, cuspidate. Corolla-lobes green, lip and stamens purplish-black.

***Canna indica**, *Linn. Vern. orientalis*, *Rosc. Fl. Brit. Ind. VI*, p. 260.

Rootstock tuberous with many fibres. Stems 3-4 ft. high. Leaves 6—18" long, oblong. Flowers distant, 2½" long, scarlet or yellow, asymmetric. Calyx 3 lobes. Corolla 3, gamo. There is a leafy stamen bearing only half-anther on one edge, and a number of petaloid structures round it. One of them is labellum.

***Musa paradisiaca**, *Linn. Subsp. sapientum*, *Schum. Duthie. Fl. III*, p. 238. Vern. *Kela*.

Tree-like herb, without stems, composed of convolute leaf-sheaths. Leaves very large, oblong, spirally arranged. Flowers in terminal spikes, practically 1-sexual, the lower female, upper male. Bracts large, spathaceous, ovate. Calyx tubular, 3—5 lobed. Petals connate, convolute round the stamens and style. Stamens 5, perfect. Carpels 3, connate in a 3-celled ovary, ovules many. Fruit oblong.

***Alpinia nutans**, *Roscoe. Fl. Brit. Ind. VI*, p. 256.

Stems 10 ft. high. Leaves 1-2 ft. by 3—6", oblong-lanceolate. Flowers very handsome in panicles, 6—12" long. Bracts large, concave, ivory white, tinged with pink, and variegated with red and yellow.

**Hedychium gardnerium*, *Roscoe. Haines. Botany.* p. 1139.

The plant is cultivated as an ornamental herb in the gardens. Flowers in long spikes, 12—18" long, lemon-yellow. Staminodes oblanceolate, 1" long. Lip obovate-cuneate, filaments light red.

III. AMARYLLIDACEAE

Agave americana, *Linn. Duthie. Fl. III*, p. 242. Vern. *Hathi chinghar*.

Perennial shrub, tuberous rootstock. Leaves large, thick, fleshy, densely clustered at the top, spiny at the tip, and usually armed along the edges; scape long terminal. Vivipary is common. Flowers only once in its life.

**Crinum latifolium*, *Linn. Duthie. Fl. III*, p. 249.

Herb with large tunicate bulbs. Leaves $1\frac{1}{2}$ —2" wide, long, linear, lanceolate, margin smooth, distinctly undulate. Flowers large, umbellate, sessile. Perianth funnel-shaped, lobes 6, lanceolate, tube long, curved, pinkish. Stamens 6, adnate to the throat of the perianth-tube, filaments free, anthers brown. Ovary 3 celled, ovules 2—many in each cell. Fruit a capsule.

IV. LILIACEAE

Asparagus, *Linn.*

Under-shrubs, with a stout creeping rootstock. Stems erect, or climbing, terete or grooved. Leaves minute, scale-like, bearing in their axils tufts of needle-like flattened axillary cladodes. Flowers bisexual, small or minute. Perianth petaloid, 6-partite, campanulate

Stamens 6, adnate to the base of the perianth segments, filaments free. Ovary 3-gonous, stigmas 3, ovules 2 or more in each cell. Fruit a globose berry.

**Asparagus racemosa*, Willd. *Fl. Brit. Ind.* VI, p. 316.

Vern. *Satmuli*.

A tall much branched scandent spinous undershrub with tuberous roots. Stem woody, terete, spinous, sub-erect, cladodes $\frac{1}{2}$ -1" long in tufts of 2-6, spreading, falcate, acuminate, channelled beneath. Racemes 1-2" long. Perianth $\frac{1}{8}$ " in diameter. Anthers minute, purplish. Ovules 6-8 in each cell.

Flowers after the rains.

Asphodelus tenuifolius, Cav. *Fl. Brit. Ind.* VI, p. 332.

Vern. *Piazi*.

Annual. Leaves 6-12" long terete, acute, sheathing at the base. Scapes several from the root, much branched above, 1-2 ft. long. Flowers white, solitary in each bract, pedicellate. Perianth connate below. Stamens 6, filaments dilated at the base and embracing the ovary, anthers versatile. Ovary 3-celled, style filiform stigma 3-lobed, ovules 2, collateral in each cell. Fruit a capsule.

Flowers: January-March.

**Allium cepa*, Linn. *Fl. Brit. Ind.* VI, p. 337. Vern.

Piaz (Onion).

Leaves fistular. Umbels dense with white flowers.

A winter season crop. Flowers: January-March.

**Allium sativum*, Linn. *Fl. Brit. Ind.* VI, p. 337. Vern.

Lassun. (Garlic).

Leaves flat. Umbels lax.

**Allium tuberosum*, Roxb. *Fl. Brit. Ind.* VI, p. 343.

Vern. *Bang gandina*.

Bulb long cylindric. Leaves flat. Umbels lax.

**Chlorophytum tuberosum*, Baker. *Fl. Brit. Ind. VI*, p. 334.

V. PONTEDERIACEAE

Eichornia crassipes, Solms. *Kashyap. Fl. Lahore*, p. 247.

An aquatic herb, free-floating or fixed. Leaves in rosettes with swollen petioles. Inflorescence peduncled, raceme. Flowers violet-blue with well-developed perianth-tube, zygomorphic. Perianth 2-lipped. Stamens 6, declinate. Ovary sessile, 3-celled, many ovuled. Fruit a capsule.

Flowers during the rains.

VI. COMMELINACEAE

Commelina, Linn.

Herbs usually slender or creeping below. Leaves ovate, lanceolate with lax sheath. Flowers in usually 2-fid cymes, emerging one at a time, from a terminal funnel-shaped spathe. Flowers of the upper cyme-branch small, deciduous, of lower fertile; fruiting pedicel and capsule retracted within the spathe. Sepals 5, the 2 inner often connate at the base. Petals 3, longer than the sepals, one larger than the others. Stamens 3, perfect, with 2-3 imperfect, anther, oblong, one longer than the others. Ovary 3-celled, rarely 2-celled, two of the cells 1 or 2 ovuled, third cell absent, or empty or 1-ovuled. Fruit a capsule.

Commelina benghalensis, Linn. *Fl. Brit. Ind. VI*, p. 370.

Stems 2-3 ft. long slender, dichotomously branched, creeping, and rooting below. Leaves 1-3" long, ovate, obtuse, sessile, pubescent, nerves 7-11 pairs, sheaths hairy, margin ciliate. Spathes 1-3 together, funnel-shaped. Sepals small, oblong, hairy. Petals blue. Ovary 3-celled. Capsule $\frac{1}{4}$ " long, 5-seeded.

In this species ripe seeds are sometimes matured underground from abnormal flowers borne on leafless branches, coming from the lower nodes of the stems. These flowers are white and smaller than the blue aerial ones which often fail to produce fertile seeds.

Flowers during the rainy season.

***Commelina nudiflora*, Linn. Fl. Brit. Ind. VI, p. 369.**

Diffuse nearly glabrous. Stems 2-3 ft., branches prostrate, often rooting at the nodes. Leaves sessile, $1\frac{1}{2}$ —3" long, lanceolate, acuminate. Peduncles $\frac{1}{2}$ " long, spreading. Spathe $\frac{3}{4}$ — $1\frac{1}{4}$ " long. The two anterior petals obvate with long claws, dark-blue, the exterior pale-blue, or white. Ovary 3-celled, third cell 1-ovuled. Capsule 5-seeded.

Flowers during the rainy season.

***Commelina obliqua*, Buch. Ham. Fl. Brit. Ind. IV, p. 372.**

A tall branching herb. Leaves 4—7" long. Ovary 3-celled, cells 1-ovuled. Seeds three.

Flowers during the rainy season.

VII. PALMAE

***Phoenix sylvestris*, Roxb. Fl. Brit. Ind. VI, p. 425.**

Vern. *Khajur*. (Wild date).

A tall graceful palm, 30—50 ft. high. Trunk clothed with persistent bases of the petioles. Leaves pinnate, 7—12 ft. long, leaflets 1-2 ft., petioles short, bearing at the base a few triangular spines. Flowers small unisexual, yellowish, coriaceous. Male flowers: white scented, spadix 2-3 ft. long, erect, peduncles much compressed, spathes 12—16" long, separating into two boat-shaped valves, sepals 3, connate, petals 3, valvate, stamens 6, filaments short, pistilodes none. Female flowers:

spadix and spathe as in male flowers, fruiting peduncles 6" long, fruiting spadix 3 ft. long, sepals 3, connate, petals 3, rounded, imbricate, staminodes 6, carpels 3, free, stigmas sessile ovules erect. Fruit oblong, terete, 1-seeded.

Flowers: January-February.

The following palms are cultivated in the gardens.

***Caryota mitis**, *Lour. Brandis.*, p. 654.

Erect tall plant, 12—25 ft. high. Leaves large, 2-pinnate or pinnatisect. Flowers unisexual, both kinds on the same plant. Stamens 15—25.

Flowers: March-April.

***Caryota urens**, *Linn. Fl. Brit. Ind. VI*, p. 422.

Trunk up to 50 ft. high. Leaves pinnate, 18—20" long, terminal, leaflet 2-3 lobed. Flowers unisexual both on the same plant. Stamens more than 25. Fruit red-dish.

Flowers: March-April.

***Areca catechu**, *Linn. Fl. Brit. Ind. VI*, p. 405. (The betelnut tree).

A very graceful palm with slender trunk, 40—70 ft. high, very straight and uniform stem. Leaves 4—6 ft. long with membranous leaflets 1-2 ft. long.

***Oreodoxa regia**, *H. B. & K.*

A very graceful bottle-shaped palm.

***Borassus flabellifer**, *Linn. Brandis.* p. 657. (The toddy palm.)

A plant with fan-shaped leaf. Toddy is extracted from it.

VIII. PANDANACEAE

Pandanus fascicularis, Lamk. *Fl. Brit. Ind.* VI, p. 485.
Vern. *Keora*.

A much branched bush, 10—12 ft. high, scandent, with stilted aerial roots. Leaves 3—5 ft. long, narrow, acuminate, coriaceous with margins spinously toothed. Flowers unisexual, on the same plant. Male inflorescence fragrant, spadix branched with a boat-shaped spinulose spathe. Perianth none, bracts and bracteoles none. Male-flowers: stamens many, filaments free or connate, anthers erect, pistillode small. Female-flowers: carpel solitary. Fruit a globose drupe.

Flowers: July—September.

IX. TYPHACEAE

***Typha angustata**, Chaub & Bory. *Fl. Brit. Ind.* VI, p. 489. Vern. *Pakar*.

Marshy herb, tall, stems 5—10 ft. high. Leaves erect, spongy $\frac{1}{4}$ —1" broad exceeding the flowering stems, sheathing below, parallel-veined. Flowers small in very dense cylindric spikes. The male and female flowers are separated by a long interval. Spikes mixed with hairs dilated at tips. Perianth of carpellary hairs or obsolete in males. Stamen one or more, connective thickened at the tip. Ovary often reduced to a clavate-tipped hair, long stalked, narrowed into a carpellary style with a clavate or filiform stigma. Fruit minute, indehiscent.

Flowers: August-September.

X. ARACEAE

Pistia stratiotes, Linn. *Fl. Brit. Ind.* VI, p. 497. Vern. *Jalkhumbi*.

Stoloniferous plants producing rosettes of spirally arranged roundish to spatulate leaves, densely pubes-

cent, the outer of which lie in water, the inner stand erect. The spathe is united with the spadix, the inflorescence consisting of a single unilocular ovary, containing numerous ovules, above which is a whorl of several female-flowers, each composed of 2 anthers, united to form a sessile synandrium. Below the male flowers is a ring-like outgrowth of the axis which may represent a whorl of abortive male flowers and below this again a green deciduous scale-like outgrowth.

Flowers: March—May.

**Colocasia antiquorum*, Schott. *Fl. Brit. Ind.* VI, p. 523.

Vern. *Ghuyan*.

**Amorphophallus campanulatus*, Blume. *Fl. Brit. Ind.* VI, p. 513. Vern. *Zaminkand*.

**Pothos scandens*, Linn. *Haines-Botany*, p. 857.

• A large climber, with variegated leaves, rooting at nodes.

**Monstera deliciosa*, Lem. *Kanjilal. Forest. Fl.*, p. 388.

A large climber with peculiar divided leaves.

XI. LEMNACEAE

Lemna paucicostata, Hegelm. *Fl. Brit. Ind.* VI, p. 556.
(Pond-weed).

Minute gregarious, free-floating aquatic herb. Fronds with a single root. Flowers unisexual, both on the same plant, 1—3 naked, enclosed in a membranous spathe, perianth wanting. Stamens 1-2, anthers 1-2 celled. Ovary 1-celled, style short, stigma funnel-shaped. 1 basal ovule. Fruit 1-several seeded, indehiscent.

Wolffia arrhiza, Wimm. *Fl. Brit. Ind.* VI, p. 557.

The smallest of the flowering plants consisting of minute fronds producing a daughter shoot in the median

line at the hinder end. Flowers breaking through the upper surface of the frond consisting of a single flower with one stamen and 1-celled, sessile anthers and a female flower with 1 erect ovule in a globose ovary.

XII. NAIADACEAE

Aponogeton monostachyon, *Linn. Fl. Brit. Ind. VI*, p. 564.

Scapigerous aquatic herb. Rootstock tuberous. Leaves floating, oblong $2\frac{1}{2}$ —8" long, with 3—5 nerves on either side of the mid-rib. Spike solitary, densely flowered. Flowers bisexual. Perianth of 1—3 segments white or coloured. Stamens 6, or more, anthers bluish-purple, didymous. Carpels 3, 2 or more ovuled, basal. Fruit follicles, 4-seeded.

Flowers during the rainy season.

Potamogeton, *Linn.*

Perennial or annual, aquatic herbs, rootstock creeping. Leaves submerged, upper floating, opposite or alternate, interpetiolar stipules. Flowers bisexual, small, greenish in spikes, bracts absent. Perianth of 4 concave valvate segments. Stamens 4, anthers sessile. Carpels 4, free, one ovule in each. Fruit of 4 coriaceous drupelets.

Potamogeton crispus, *Linn. Fl. Brit. Ind. VI*, p. 566.

Stems slender, compressed, much branched. Leaves submerged, linear, oblong, semiamplexicaul, translucent, 3-nerved, crisped, serrulate, sessile. Spike $\frac{1}{2}$ " long, few flowered, lax, above water. Drupelets ovoid, tipped with a compressed beak.

Flowers: March-April.

Potamogeton pectinatus, *Linn. Fl. Brit. Ind. VI*, p. 567.

Stems filiform, much dichotomously branched. Leaves 1—4" long, filiform. Spike 1" long, few flowered.

Flowers: October—March.

Zannichellia palustris, *Linn. Fl. Brit. Ind. VI*, p. 568.

Aquatic slender herb in fresh water. Stems filiform, rooting at nodes. Leaves submerged, linear. Flowers unisexual on the same plant, minute. Male flowers pedunculate, perianth absent, anthers adnate to the ex-current connectives. Female flowers with a hyaline cupular perianth, carpels 1—8, usually 4, style short, ovule solitary pendulous. Fruit a follicle.

Flowers: February—April.

Naias graminea, *Del. Fl. Brit. Ind. VI*, p. 569.

Submerged aquatic herb. Leaves opposite or whorled. Flowers minute, unisexual, on the same plant. Male flowers: perianth two whorls, outer tubular, entire or bifid, linear hyaline, stamen 1, adnate to the inner perianth, anthers 4- or 1-celled. Female flowers: perianth absent, carpel solitary, sessile, style cylindric, stigmas 2 or 3, ovule basal erect. Fruit an achene.

Flowers: August-September.

XIII. CYPERACEAE

Cyperus difformis, *Linn. Fl. Brit. Ind. VI*, p. 599.

An erect annual, glabrous herb, usually 1 ft. high. Stem base covered with loose membranous sheath. Stem finely striated longitudinally smooth. Leaves shorter than the stem, smooth, flaccid. Inflorescence of about 3—6 compact heads of spikelets, nearly globose. Spikelets $1/6$ " long, 10—30 flowered. Stamens 1-2. Nut trigonous, obovoid.

Flowers: August—January.

Fimbristylis diphylla, *Vahl. Fl. Brit. Ind. VI*, p. 636.

Tufted, 2—24" high. Stems striate. Leaves as long

as the stem. Spikelets in simple or compound umbels, ovoid, Glumes $1/10''$ long.

A common rainy season weed.

Juncellus pygmaeus, *Clark, Fl. Brit. Ind. VI*, p. 596.

An erect annual, with numerous stems close together in tufts. Each stem is covered by entire sheathing, often reddish leaf-bases. Leaf-sheaths loose fitting, with oblique mouths, blades linear, acuminate. Inflorescence a dense solitary terminal head, $1/3—\frac{1}{2}''$ in diameter.

Helleocharis (Eleocharis) plantaginea, *R. Br. Fl. Brit. Ind., VI*, p. 625.

Stems rush-like, marsh plant, 1—3 ft. high, terete, tufted, longitudinally striate, and distantly transversely septate when dry, sheaths membranous, soon torn, somewhat fibrous. Spikelets $\frac{1}{2}—1\frac{1}{2}''$ long, about the same diameter as the stem.

Scirpus michelianus, *Linn. Fl. Brit. Ind. VI*, p. 662.

Annual, root fibrous. Stems 1—5" high, tufted, triquetrous, leafy below. Spikelet $1/8—1/3''$ long, numerous, in dense terminal heads, $\frac{1}{4}—\frac{3}{4}''$ in diameter.

Kyllinga monocephala, *Rottb. Fl. Brit. Ind. VI*, p. 588.

An erect glabrous herb with horizontally running rhizomes. Each stem leafy below and terminated by 1—3 sessile heads, forming spikes, usually composed of numerous closely crowded spikelets. Each group of spikes is accompanied by 3-4 leaf-like bracts. Spike subglobose, $\frac{1}{4}''$ in diameter, solitary.

Flowers: July—September.